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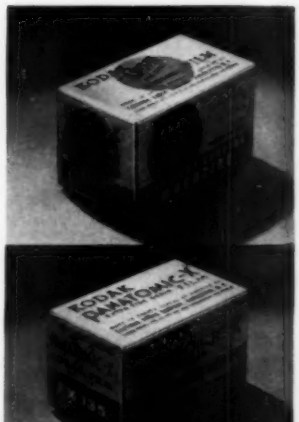

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The Scientific Approach to Modern Life

THE spirited address in defence of modern youth which Lord Tweedsmuir delivered on his installation as chancellor of the University of Edinburgh in July last has much to commend it to the attention of scientific workers. In describing the functions of a university, he added one more to the many voices warning us to-day that we must zealously defend the freedom and the integrity of our thought, boldly facing new conditions, ready to meet every problem, shirking no difficulty, but rigid in our fidelity to the laws which govern our intellectual being.

A university, Lord Tweedsmuir asserted, must transmit and advance knowledge. It is not only a seminary for the training of youth but also a museum for record, a laboratory for discovery and a power-house for inspiration. These duties are closely united, for without a centre of creative thought behind them, the professions for which the university trains youth will become stagnant and blind.

The maintenance of the delicate structure which we call civilization in the face of the destructive forces at work in the world to-day is a task to which the university must make an indispensable contribution. That task is not rendered the easier by any retreat to the older philosophies. Even if we can select one of the older systems as the basis of all learning, it is no simple matter to link it up with the multitudinous activities of the modern world, the study of the physical universe and of the infinite ramifications of human society. To select arbitrarily a set of first principles and to make all studies subordinate to them is in effect, as Lord Tweedsmuir pointed out, to establish an intellectual dictatorship and to kill the freedom of the mind.

Significantly enough, Lord Tweedsmuir suggested that we should aim at giving our youth minds accustomed to think and inspired by a reverence for thought. At the same time, they must have the perspective created by some understanding of our long human story. Only thus can we endow them with what is most needed—confidence and hope. He went on to urge the claims of scientific research as a career, whether in the service of the universities, or industry, or of the State. Such a career, he said, offers a life of perpetual adventure, and in that field every university can do useful work.

There is indeed ample room for the spirit of adventure to-day and for the discipline behind it which makes adventure fruitful. Conceived in this way, scientific research offers a great opportunity, for it becomes linked to the development of personality, and the exploration and recognition of human values. The great and enduring human values inherent in our democratic institutions cannot be maintained by trying to stabilize the machinery through which they find expression. They can only be defended by being made to work effectively, and unless we can modify our institutions in line with the profound changes in the complexity and conditions of government, they may well perish.

Here, as Major L. Urwick suggested in a recent stimulating paper published in the *British Management Review* on "Administration and Society" is one of the challenges thrown down to modern youth : research into the human and social aspects of administration and government, which will yield the scientific knowledge by which we can bring mechanization under control and adjust accurately our social organization. The ideals and

experiments outlined by E. Mayo in "Human Problems of an Industrial Civilization" (New York, The Macmillan Co., 1933) or T. N. Whitehead in "Leadership in a Free Society" (Oxford University Press), are only beginnings, but are pregnant with possibility.

It is indeed the neglect in the past of human purpose, psychological factors and social factors by industry that leads Gillespie in his recent book "The Principles of Rational Industrial Management" (London: Sir Isaac Pitman and Sons, Ltd., 1938) to reject the whole term 'scientific management'; for some of the protagonists and practitioners have undoubtedly been prone to overlook the limitations of science in management. Scientific method is only a tool of management. It is not the whole of management, and is not a substitute for personal values. Moreover, as Gillespie points out, not only has the social purpose of industry been neglected and its social responsibilities overlooked, but also management has often failed to recognize the significance of its own obedience to the purpose which industry is serving. It is a sound principle that one of the first steps in training for leadership is learning to obey, and management has often failed in obedience to its own rules and precepts, and to the full purpose which industry should serve.

Conceived on these lines, we need not fear that democratic institutions cannot be moulded by youth to meet the challenge of to-day. The problem of freedom, once more a cause to fight for, is encountered everywhere, no less in industrial than in national life. No less in the industrial unit than in the nation, the first condition of freedom is stability and a sense of justice, inspiring the loyalty which accepts not discipline so much as self-discipline and the co-operation and good will for free service in a common aim.

This is essentially the moral rearmament of which Sir William Bragg spoke in a recent broadcast address. Only the vision and inspiration of a great and noble purpose can suffice to rally youth to the task, not of service in the sense of defence only, but of building a new world order in which every individual and every community may find full opportunity for self-expression and development, and in which the national defences now being so hurriedly erected can be made unnecessary. This task demands much patient and painstaking research. It involves a wide vision and wise judgment in the direction of such research, and the reorientation of such effort, as well as the institution of research in fields yet largely untouched. It demands, too, the free acceptance of discipline and loyalty to the idea of service, and a capacity to evaluate all the issues, to see life steadily and to see it whole, which should appeal to all that is best in youth and command its steadfast allegiance and noblest endeavours no less than the daring and fortitude to which Lord Tweedsmuir paid tribute. Lord Tweedsmuir's address has earned the gratitude of all scientific workers, whether of the younger or of the older generations, no less for the clarity with which he has defined the challenge than for the inspiration with which it summons them to seize the opportunities which lie beyond that challenge.

International Co-operation in Geology

Lexicon de Stratigraphie
Vol. 1: Africa. Edited by Dr. S. H. Haughton. Pp. vi+432. (London: Thomas Murby and Co., 1938.) 31*s.* 6*d.* net.

A COMMISSION, elected at the fifteenth meeting of the International Geological Congress assembled at Pretoria in 1929, decided to produce a "Lexicon de Stratigraphie", with a volume devoted to each continent in turn. The general editorship was entrusted to Dr. S. H. Haughton, who has naturally started with Africa.

The purpose of each volume is to furnish definitions of all stratigraphical terms that have appeared in the geological literature of the particular continent, and to arrange them for convenience of reference in alphabetical order. The definitions must be accompanied by appropriate references and must indicate past and present meanings. Thus, in the case of a formation of local origin, the original meaning is cited along with the more significant of subsequent changes. Comments are added regarding geographical and geological relations; the whole, of course, in brief dictionary style.

In the present volume Dr. Haughton has been assisted by twenty-three collaborators, whose contributions are duly initialled. Most of them have written in English or French, a few in Italian.

In the text, the stratigraphical unit is used as the main heading, under which detail is subdivided according to country. In the index this arrangement is reversed—a very convenient device.

There are more than 1,100 stratigraphical headings in the course of 419 pages. Groups of systems, such as Palæozoic, are not mentioned; but from systems downwards any unit seems to have been acceptable. At the same time, there are very few in the list which owe their name to a fossil. Thus, though the *Nummulites gizehensis* Beds and the *Tapinocephalus* Zone occur in their alphabetical position, one must look up Cénomanien to find mention of the Zone à *Acanthoceras rotomagense*, and Aalénien for the Zone à *Harpoceras murchisonae*.

Obviously the treatment is uneven; this, however, is not only unavoidable, but also, within limits, desirable. The result is extremely valuable and definitely intriguing. One is led on from page to page among unfamiliar names or names with unfamiliar associations. The Chiwondo Beds, one learns, along with much other information, have *Cleopatra* among their characteristic molluscs; the Variegated Marls, defined in 1900, occur in the lower part of the Uitenhage Series, and in 1928 have been classed with the Wood Beds. Taking the volume as a whole, the best comparison, perhaps, that can be made among geological utilities is with Holmes's "Nomenclature of Petrology".

This lexicon should certainly be added to every important library that deals with the pure or applied aspects of geology. It represents one of the many benefits which have been derived from the International Geological Congress. British geologists now await instructions from Dr. Haughton before starting on their share of the European volume which, we may hope, will appear in separate parts. We want to be able to report good progress when the Congress meets in London in 1940.

E. B. BAILEY.

The Negro in the United States

The Negro's Struggle for Survival: a Study in Human Ecology. By Prof. S. J. Holmes. Pp. xii + 296. (Berkeley, Calif.: University of California Press; London: Cambridge University Press, 1937.) 13*s.* 6*d.* net.

THROUGHOUT Nature the struggle for existence is usually an orderly and peaceful process, and it may not be possible to explain in simple terms just why one species succeeds in supplanting another. Only occasionally even in the animal world can such replacement be attributed to superiority in open conflict. In the history of man, too, it has been the bloodless battles in times of peace, between obscure biological forces affecting the balance of births and deaths, which have generally proved more decisive than wars in deciding which peoples shall survive and which shall disappear. This aspect of human evolution is emphasized and well illustrated by Prof. S. J. Holmes in his thoughtful examination of the vital statistics of the Negro in America.

The white man's impact on primitive peoples has often been deadly in its results. In his explorations, he has inadvertently taken with him the scourges of measles, influenza, pneumonia and tuberculosis. In his 'civilizing' mission he has introduced the curses of alcohol, venereal disease and clothes. Some native populations such as those of Tasmania and Australia have in consequence given up the struggle for survival, whilst others as in the Pacific Islands have been threatened with extinction. In some parts of the world the Negro peoples have been able, fortunately, to survive the devastations of their first contact with the white race. They have thus been able to reap some of the benefits of improved hygiene, the prevention of tribal wars, and the saving of infant life, but now they are faced with a more insidious threat to their future welfare in the fall of their reproduction rate. It is mainly with this problem of the balance of births over deaths amongst the Negro population of the United States of America that Prof. Holmes deals.

Under slavery, most Negroes were employed on farms and plantations of the southern States and their health was relatively good, but the Civil War changed this. The terrible conditions of the Negro's first decade of freedom brought in their train a great increase in tuberculosis, syphilis, malaria, pellagra and other debilitating diseases. The records of the cities indicate that the Negro death-rate continued to rise for nearly a quarter of a century after the Civil War, but notwithstanding an infant mortality which carried away every third or fourth child, their high fertility still enabled the Negro population to increase. The first decades of this century witnessed a rapid fall in their mortality; but the effects of this were offset by a falling fertility amongst those

who took to town life. Urban life is not so well tolerated by the Negro as by the white, the advantages of a relative immunity to some infections such as scarlet fever, diphtheria and erysipelas being more than counterbalanced by a greater liability to bronchitis, pneumonia and other diseases of towns. The great trek of 1917–18 to the cities of the north which resulted from restriction of alien immigration therefore exacted at first a heavy toll on the balance of births over deaths, but the adjustment was made.

At present, according to all available measures of fertility, the Negro women are reproducing more rapidly than the white women in the United States, and taking into account their greater death-rate, Prof. Holmes concludes that there is at the moment a neck and neck race with a fair prospect that the Negro may soon be increasing at the faster pace. This depends on many uncertainties, such as the increasing use of contraceptives in rural communities and the conquest of the scourge of venereal disease. It is a problem which will engage the attention of students of population and eventually of administrators to an increasing degree, and Prof. Holmes has rendered no small service by gathering together such a wealth of statistical material and interpreting it with such commendable caution. P. S.

Early French Men of Science

Figures de Savants

Tome 3 : l'Académie des Sciences et l'Étude de la France d'Outre-Mer de la Fin du XVII^{e} Siècle au Début du XIX^{e}. 1 : Antilles et Guyane. Par Alfred Lacroix. Pp. xiii + 220 + 38 plates. 125 francs. Tome 4 : l'Académie des Sciences et l'Étude de la France d'Outre-Mer de la Fin du XVII^{e} Siècle au Début du XIX^{e}. 2 : Mascareignes, Madagascar, Inde, Indochine, Pacifique. Par Alfred Lacroix. Pp. iv + 259 + 59 plates. 150 francs. (Paris : Gauthier-Villars, 1938.)

IN these two well illustrated volumes, the permanent secretary of the Paris Academy of Sciences has collected a very useful and instructive series of short notices of the distinguished Frenchmen who promoted the cause of science in the French Empire during the later part of the seventeenth and the eighteenth centuries. The Academy itself, of which M. Lacroix gives a short account, had during the seventeenth century no permanent home. It received help from Colbert, who was always prepared to further French colonial interests, and it was finally installed in the Louvre by the King in January 1699.

In these volumes, the men of science dealt with appear under a geographical arrangement. Vol. 3 contains notices of those working in the West Indies, Guiana, the Mascarene Islands, Madagascar, India and Indo-China. The last four countries are again represented in vol. 4 together with West Africa. A separate section in this volume is devoted to the family of Jussieu, five of whom were distinguished naturalists. The volume ends with a plea for some central organization to deal with research at the present day.

It is not possible in a short space to give an adequate idea of the wealth of information which M. Lacroix has collected in these four hundred and fifty pages. The particular interest of the Academy in astronomy and physics is represented, for example, by Jean Richer's mission to Guiana in 1666 and by a similar mission of La Condamine in Peru and Guiana. Richer's work on gravity was of outstanding importance. Similarly we have a picture of Peyssonnel and his work on the polyps, begun in the Mediterranean and completed in Guadaloupe. He received little recognition at the time in France, but his work was published by the Royal Society and he was made a foreign member. Bouvet, better known as the discoverer of a small island to the south of Africa, is shown in these pages as the patron of Poivre, who did valuable work on spices. Two other notable explorers, Kerguélen and Lapérouse, appear in a more familiar setting. Sir Joseph Banks is mentioned several times. His intervention secured the return to France of the botanical collections of La Billardière after their capture by the Dutch. Some interesting correspondence on this matter, and on the question of Sir Joseph's failure to secure election to the Academy, and a similar failure of Jussieu to secure election to the Royal Society, is reproduced.

The omission to index a reproduction of a letter of Jussieu to the Minister of Police has made the references to the portrait of Banks (Pl. xlviii) and a facsimile reproduction of his letter to Delambre (Pl. xlix), and of subsequent plates incorrect, while the numbering twice over of Plate xxxix in the "Explication des Planches" has thrown all subsequent references therein wrong. But these are trifling inconveniences in a work which is full of illuminating if disjointed appreciations of the great men of science of France. J. N. L. B.

Stellar Physics

Physik der Sternatmosphären: mit besonderer Berücksichtigung der Sonne. Von Prof. Dr. A. Unsöld. Pp. viii + 500. (Berlin: Julius Springer, 1938.) 66 gold marks.

IT is clearly recognized how closely the rapid progress in astrophysics has been linked up with the advancement of physics since the beginning of this century. Taking into account the fundamental theoretical work of Schwarzschild, it would appear that astrophysics became a 'quantitative science' only during the past thirty years. The new problems arising during this period have resulted in an extensive literature, the material of which has been partly collected in voluminous handbooks. But what was badly needed at the present stage (especially for those who wanted to enter the new fields of research, and found themselves confronted with this mass of material), was a critical and, so far as possible, systematic study of the subject.

The present book fills this gap most happily. The author is a distinguished astrophysicist, whose own contributions to science are of fundamental importance. His theoretical work shows a rare insight into the conditions of observational astrophysics, and into its limitations. It is significant also that in his present book Unsöld resists all temptations to follow up theoretical developments for their own sake. He succeeds very frequently in re-presenting theories in a new and simplified form. This and the great care he takes to deal with the observational material available, make his book readable and useful, both for the theoretical and for the practical workers in the field.

The volume consists of five parts. The first one, on more general lines, serves as a kind of introduction to the detailed treatment of the later chapters. After a brief review of the physical theory of radiation, the author deals with general problems of solar and stellar radiation, such as the solar constant and the effective temperature of the sun, brightness and colour temperature of stars. A chapter deals with Saha's formula and its application to stellar atmospheres, and gives a survey of its limitations.

Turning to the second part of the book, we are given a thorough analysis of stellar atmospheres and of their radiation, so far as the continuous spectrum is concerned. Naturally the theory of radiative equilibrium is treated in all important details. The law of darkening towards the limb, and its dependence on wave-length, are other topics contained in this chapter, the second and main part of which is devoted to the continuous absorption coefficient. Introducing Rosseland's mean value $\bar{\varkappa}$, the author develops the physical theory of the continuous absorption coefficient, describes the experimental tests of its validity, and applies, finally, the results obtained to solve the problem of the energy distribution in the continuous spectrum of the stars.

From the discussion of the continuous spectrum the author passes to the vast realm of the absorption lines, to which naturally the major part of the book is devoted. The introductory third part gives an account of all that physics knows about the formation of absorption lines. Here we meet the classical theory of representing the atom by damped harmonic oscillators. The treatment then follows on the basis of the quantum theory, in which, for example, radiation- and collision-damping as well as the intermolecular Stark effect are dealt with. The quantum-mechanics computation of transition probabilities and oscillator strengths is given, and, on account of the importance of multiplets, the Burger-Dorgels rule is treated in a special chapter. Finally, the experimental side of the problem is well represented; such items as the measurement of oscillator strengths, experiments on the broadening by collision, damping or Stark effect, etc., are clearly discussed.

This physical interlude is followed in the fourth part by the treatment of the fundamental problem of the Fraunhofer lines, the absorption lines of astrophysics. After a brief survey of observational questions which is very useful for the beginner, we find here the necessary extension of the theory of radiative equilibrium, given in preceding chapters, so as to include line radiation. The well-known Schuster-Schwarzschild and Milne-Eddington models and their generalizations are dealt with in detail. It is shown that the main problem in the theory of the Fraunhofer lines is to find from measurement of the intensity of the line the number of absorbing atoms. The author gives the corresponding relations on the basis that the broadening of a line is mainly due to the Doppler effect and to damping. The influence of these effects, and especially of the second one, in stellar atmospheres is shown, as well as the importance of the intramolecular Stark effect for the hydrogen lines. In this same chapter the theory of central intensity, the role of interlocking, and the problems of the blends are treated. The study of outside factors causing broadening, such as rotation, or expansion of a stellar atmosphere, concludes this most interesting section.

The beginning of the fifth and last part of Unsöld's book is devoted to the applications of the theory of Fraunhofer lines to the problems of spectral classification, and to a quantitative analysis of the solar atmosphere. The last two chapters deal with the outer layers of the sun. Here, we find, first of all, studies on sunspots, faculæ and granulation (an example of the role of convection in stellar atmospheres), and, further, an account of our physical knowledge of prominences, the chromosphere, and the corona.

The work is concluded by a well-arranged bibliography, which comprises no fewer than 1,800 entries.

A review of this unique book can only give an outline of its contents and its purpose. The author has fulfilled his intentions in an admirable way; and his work is likely to prove indispensable to all workers in astrophysical and related fields. It fills a real gap in astronomical literature, in which we were lucky enough to welcome some time ago Rosseland's "Theoretical Astrophysics", treated on quite different lines (see NATURE, 138, 628, 1936). Prof. Unsöld has rendered a great service to astronomers as well as to physicists, who will be glad to make use of the fundamental problems and their solutions arising from a study of those great physical laboratories, the stars. A. B.

The Liberal Arts Applied to Modern Medicine

The Doctrine of Signatures: a Defence of Theory in Medicine. By Scott Buchanan. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xv + 205 + 20. (London: Kegan Paul and Co., Ltd., 1938.) 7*s*. 6*d*. net.

IN the form of a plea for renewed freedom of speculation in thought, Prof. Buchanan has written a very interesting book in which he is not concerned with social and political restraints, but with the far more stultifying hesitations in the minds of thinkers of the present time. He is alarmed to find all around him, evidence of the fact that the intellectual process is being called in question and its consequences feared. As subject-matter for investigation, Prof. Buchanan has chosen the science and profession of medicine, which throughout European history has always fought and won the battle for freedom of thought, but which, now that it is in possession of victory, stands hesitating at the head of the sciences, burning with intellectual energy and imagination but not knowing which way to go. In Prof. Buchanan's opinion, modern medicine is suffering from a lack of balance of the intellectual virtues, and while it has a "maximum of informatory knowledge, has a minimum of understanding".

For this unhappy state of affairs, Prof. Buchanan prescribes two remedies, which he maintains are forgotten rather than new. These are the use of symbols and of demonstration—or in other words, the application of the liberal arts—the trivium and the quadrivium, to medical education. Here, the patient becomes a text to be read and translated according to the rules of medical grammar. For according to the doctrine of signatures, medical knowledge consists of seeing the connexions between symptoms and remedies; and the liberal arts are concerned with signs and symbols and also with the levels of generality and abstraction that appear when symbols are used. Prof. Buchanan accuses modern scientific medicine of elaborate empiricism and anti-intellectualism, and thinks that the doctrine of signatures and the liberal arts would be good exercise for our weak symbolic faculties. Furthermore, he alleges that the disuse of demonstration in the biological and medical sciences has tended to atrophy the understanding, and proceeds to show how Plato, Aristotle and Galen discovered and established the demonstrative power of form and matter in biological science. He thinks that its re-discovery and re-establishment would both revive and direct our stultified speculative energies.

There is no doubt that Aristotle and Galen represent the peak of Greek medical science; but Prof. Buchanan maintains that to-day we are only working out the details of their fundamental insights. To support this view, he states that students of the history of medicine are repeatedly disclosing the fact that the greatest of original modern discoveries in physiology and anatomy are but the discoveries of ideas and illustrations of principles in the Aristotelian and Galenic works. While he would not go so far as to say that there is nothing new in science, he assures us that we have yet to recognize the science which has made possible such novelty as there is. We should try to recover the doctrines of the tradition from which modern developments have grown, in the hope that they may be rendered intelligible enough to "absorb modern science within the borders of their ancient wisdom".

The subject is certainly a fascinating one, and Prof. Buchanan's treatment of it, although necessarily rather fragmentary in a book of this length, is both stimulating and disturbing.

Plant Physiology

By Prof. Nicolai A. Maximov. Edited by R. B. Harvey and A. E. Murneek. (McGraw-Hill Publications in the Botanical Sciences.) Second English edition, translated and revised from the fifth Russian edition. Translated from the Russian by Dr. Irene V. Krassovsky. Pp. xxii+473. (New York and London: McGraw-Hill Book Co., Inc., 1938.) 25*s*.

NICOLAI MAXIMOV is a plant physiologist with a world-wide reputation, especially in connexion with the water and soil relations of the plant, and this alone justifies a translation from the Russian of any work of his, even if it is only a survey of the subject for the benefit of the student. In spite of the fact that there are now several good text-books on plant physiology in English, written by British and American authors, one by this well-known Russian, who is an active worker and prolific writer, is bound to bring a certain freshness of outlook, so that it may be regarded as a valuable supplement to any text-book which the student is already using.

This second English edition has been translated from the fifth Russian edition, which was so completely rewritten by Prof. Maximov as to warrant a new title. (The first edition was entitled "Textbook of Plant Physiology".) It should be pointed out, however, that Prof. Maximov's researches are biased towards plants of agricultural importance, and thus this book deals, as he terms it, more with "agrophysiology" than with general plant physiology. Thus the physiology of saprophytes, parasites, bacteria, fungi and algæ is scarcely considered. The book can therefore be strongly recommended as a text-book to students of agriculture and as a supplementary book to students of general botany, since its economic outlook will certainly give added interest to their studies.

The subject-matter is considered in the orthodox manner under such headings as physico-chemical organization and chemical composition of the plant, respiration, growth, photosynthesis, nitrogen assimilation, absorption of mineral elements, water relations, translocation and so forth. Certain subjects such as growth, development and seasonal phenomena receive fuller and better treatment here than in most books on the subject. The book deserves unqualified success.

A Text-Book of Biochemistry:

for Students of Medicine and Science. By Prof. A. T. Cameron. (Churchill's Empire Series.) Fifth edition. Pp. viii+414. (London: J. and A. Churchill, Ltd., 1938.) 15*s*.

THE fourth edition of this very successful text-book was reviewed in NATURE of January 6, 1934, p. 8. There have been a total of ten editions and reprintings since the original publication of the book ten years ago, so there can be no questioning its utility, especially to medical students, to whom it is primarily addressed.

Any text-book dealing with such a progressive subject as biochemistry is naturally bound to become quickly out of date in parts, so the success of this work is of particular value in offering the author opportunity of revision in the light of recent research. The author has availed himself of the opportunity, with the result that this new edition has been almost completely rewritten. The subject-matter has also been re-arranged. As in the previous edition, the author has assumed a basic knowledge of organic chemistry, but justifiably opens with a résumé of the concepts of physical chemistry. Thence, the student is brought directly into contact with "biochemical agencies"—enzymes, hormones and vitamins. Here, the subject-matter has been severely curtailed, apparently to satisfy the immediate needs of the medical student. Phytohormones, as such, are dismissed in one sentence, though certain of them, such as indole-acetic acid, indole-propionic acid, skatole, etc., are considered farther on in the book in connexion with the action of intestinal bacteria.

The chapters on the biochemistry of the foodstuffs leave nothing to be desired. We are glad to note that the author has corrected a previous error and here states correctly that strophanthin hydrolyses to glucose, cymarose and strophanthidin.

The rest of the book deals with those branches of biochemistry essential to students of medicine, and concludes with a consideration of pharmacology and of immunochemistry and the chemistry of filterable viruses. The book is a pattern of compression; in fact, to survey such a wide subject in four hundred pages so satisfactorily is a feat of which the author may well be proud.

Icones Plantarum Sinicarum

Fascicle 5. Edited by Hsen-Hsu Hu and Woon-Young Chun. Pp. iv+50+plates 201–250. (Peiping: Fan Memorial Institute of Biology, 1937.)

THE publication of fascicle 5 of the "Icones Plantarum Sinicarum" brings the total of plates published in this work to two hundred and fifty. The illustrations are in black and white, most plates include analyses and many show both flowers and fruits. One species is figured on each plate and described in the text in English and Chinese. Nearly all the subjects are woody plants (only five herbs have been figured so far), and the large size of the plates (the work is a folio) is a great advantage in that it allows ample material of the plants to be illustrated. The value of the work is enhanced by the fact that many of the plants figured, especially in fascicles 3–5, are species described in recent years, whilst another valuable feature is the figuring in successive plates of all or most of the Chinese representatives of one genus, as, for example, in *Carpinus*, *Tilia* and *Deutzia*. In the first two fascicles the plates are spoilt, to a large extent, by being too heavily inked, but in fascicles 3–5 they are excellently reproduced from drawings (by C. R. Feng) which are both artistic and botanically accurate. The publication forms a valuable work of reference for students of the flora of China, and it is to be hoped that it will be possible for production to continue, despite the unhappy conditions now prevailing in that country.

Arctic Eskimo:
a Record of Fifty Years' Experience and Observation among the Eskimo. By C. E. Whittaker. Pp. 260+16 plates. (London: Seeley, Service and Co., Ltd., n.d.) 16s. net.

IN his fifty years of experience of the Eskimo, Mr. Whittaker has seen many changes. In that period much of their traditional mode of life has passed away, while in other respects, although superficially there has been little modification, conditions have altered fundamentally. To mention one instance only, though one that is most important for the future of the race, the scarcity of game has adversely affected hunting and trapping activities, and had not the Canadian Government intervened, the situation would have been parlous indeed.

It was, however, the whaling industry that played the most serious part in breaking down Eskimo culture, introducing the commodities, foods and especially drinks, and the diseases of civilization. When the whaling industry died out some thirty years ago, the condition of the Eskimo began to improve, and thanks to missions and hospitals, as well as in a lesser degree to schools, progress has been continuous.

In this volume the author is concerned with the traditional culture of the people rather than their present condition, although he glances at this incidentally. His most permanent and valuable contribution to understanding of the Eskimo and the character of their culture, lies in his personal observation and contact with individuals, of which his memories provide a store. His appreciation of their character with all its good qualities, as well as its weaknesses, is successfully conveyed to the reader.

The author deals chiefly with the inhabitants of the Mackenzie Delta and Hershel Island, and the Copper Eskimo of Coronation Gulf, who had not been visited by the white man before 1914; but his account of these peoples is made the basis of an account of the Western Eskimo in general.

Grass Drying
By S. W. Cheveley. Pp. 127+9 plates. (London: Ivor Nicholson and Watson, Ltd., 1937.) 6s. net.

THIS book fulfils a need in that it deals shortly but concisely with the whole subject of grass drying, tracing its development from the initial experiments at Cambridge to the product now turned out by the modern grass dryer. The general principles of grass drying are well set out, and some general idea of costs can be ascertained from the figures given. It is unfortunate that all figures are taken for one make of dryer only, and that no figures are given for plants suitable for the farmer whose intention primarily is to supply his own requirements.

The two chapters dealing with the management of the grass before and after cutting, and the general organization of the work, are well set out.

The feeding value of dried grass is given, as are suggested methods of feeding the material to different classes of stock. No results are quoted from actual feeding trials though many trials have been carried out. Reliable information of this nature, from properly designed and managed trials is, however, still needed, especially on the comparative value of spring and autumn dried grass. Methods of feeding and amounts to be fed will probably need revising when experimental results relating to these subjects are available.

No book dealing with a subject yet in its infancy can be expected to keep abreast of conditions for more than a short time. Even now, dryers other than those specified are being marketed, but no one contemplating the outlay on a drying plant can fail to benefit from reading this book. J. R. M.

The Production of Field Crops:
a Textbook of Agronomy. By Prof. T. B. Hutcheson, T. K. Wolfe and Prof. M. S. Kipps. (McGraw-Hill Publications in the Agricultural and Botanical Sciences.) Second edition. Pp. xvii + 445. (New York and London: McGraw-Hill Book Co., Inc., 1936.) 21s.

THIS is essentially a book written to meet the requirements of an American course of agriculture, and it deals only with American crops and conditions; it makes no claim to be of direct use to students or teachers in Great Britain. The terminology will be strange to English readers, and many of the crop varieties mentioned are rarely heard of here.

Some of the sections, however, are of interest to English readers. One gives brief results of trials on the placement of fertilizers in relation to seed, though with the information available from American sources, much more might have been made of this subject. Another relates to the necessity of small quantities of the rarer elements for plant growth, but the practical application of this knowledge is not discussed. No mention is made of the use of mercurial seed dressings against 'bunt' and 'smuts' in cereals, the formaldehyde and copper carbonate treatments being recommended. J. R. M.

The Naturalist's Calendar ("With Camera and Notebook"), 1939
Edited by Phyllis Barclay-Smith and Rudolf Zimmermann. Pp. 60. (London: M. C. Forrester, 1939.) 3s. 6d. net.

THIS handsome calendar should be welcomed by all lovers of natural history, since it forms an attractive vehicle for some excellent Nature photographs, which not only portray the beauties of plants and animals but are also an adequate and ready means of identification. Each page on the calendar represents one week; but the letterpress is purely supplementary to the pictures. The photographs are of mammals, birds, insects and plants found in Great Britain and have been chosen from among the best works of well-known naturalists.

The calendar would adorn the wall of a naturalist's study or a biological lecture room or laboratory. It would make a very acceptable gift to any one interested in the natural history of any group of plants or animals.

The Physiology of the Plant Cell*

By Prof. W. Stiles, F.R.S.

IN spite of its great importance for the life of man, the physiology of plants is a subject of comparatively recent development. In its earlier phase, during the eighteenth and first half of the nineteenth centuries, it was very largely a study of plant nutrition, from which emerged certain definite information regarding the functions of various plant organs and tissues. It is only more recently that the study of the activities common to all living cells has come to the forefront of physiological inquiry. These activities can conveniently be considered as of two kinds. In the first place all cells respire, in the sense that so long as they are alive, actions proceed in them which involve the release of energy from certain substances. With very few exceptions, these actions take the form of a breakdown of carbohydrate or fat by oxidation to carbon dioxide and water. The second kind of activity exhibited by all cells is to be found in their capacity for absorbing and excreting water and dissolved substances.

It is usually accepted as a fact that every living cell respires, and if this is so, then we must conclude that respiration is something most inextricably connected with life. The general view held regarding the function of respiration, put in as precise terms as possible, is that it provides energy for certain plant movements, and for the building up of substances of higher energy content than the products of photosynthesis which serve as the substrate. While perhaps all plant movements do not obtain the necessary energy for their occurrence from respiratory activity, no doubt some do, and there is every reason for believing that the energy required for the production of various constituents of the plant arises from the same process. But having agreed to this, can we really be satisfied that we have obtained a complete explanation of the function of respiration? In the case of germinating seeds, growing organs, the formation of flowers and fruit, this view seems completely adequate; but we must remember that storage organs, such as potato tubers and carrot roots, respire at a by no means negligible rate and that the same is true of senescent organs such as mature fruit. Indeed, such tissues, notably those of the apple, have provided some of the most interesting data of plant respiration. With what movement, or with what synthesis of materials, is respiration of the cells of the mature apple concerned?

Such considerations lead one to wonder whether respiration is not concerned in some much more subtle way with the maintenance of life. It looks as if the mere maintenance of the protoplasm in a living condition depends on the continuous occurrence of those processes which manifest themselves in the oxidation of organic material to carbon dioxide and water by means of absorbed oxygen. The only exception to this rule is found in certain so-called resting organs, such as seeds, in which the amount of water present is very low, and in which, presumably, the protoplasm is in some very different state from that of active cells.

If we cannot answer this question we can, at any rate, attempt an examination of the functions of respiration of which we feel more certain. The most universal of these is the provision of energy for the building up of materials of higher energy content. The chief problem which awaits solution here is the mechanism by which the energy released in the oxidation of the substrate is transferred to the actions bringing about the synthesis of proteins and other complex plant constituents. A consideration of the relationship between aerobic respiration of apples in air and oxygen and anaerobic respiration in nitrogen led F. F. Blackman to the view that, along with the breakdown of carbohydrate, there is in air a process of oxidative anabolism in which some of the intermediate products of the breakdown of carbohydrate are built back into the system. Evidence for oxidative anabolism in storage tissues such as potato tuber and carrot root has also been obtained in my laboratory by W. Leach, J. K. Choudhury and J. K. Scott, while the investigations of Bennet-Clark on the organic acid metabolism of succulents and other plants has led him to the conclusion that not only does oxidative anabolism occur in these plants, but also that organic acids may quite generally play an important part in this phenomenon.

While then data are accumulating which indicate the linkage of anabolic processes with those of the breakdown of sugar, it is important to note that there is no evidence of the formation of products other than carbohydrates. Is it not possible, however, that syntheses of more complex

* Based on the presidential address read before Section K (Botany) of the British Association at Cambridge on August 18.

substances are indeed involved, and that we have here a dim glimpse of the mechanism for the production of these substances, and that along with the formation of sugar or some intermediate, there may also be the formation of protein or other complex substances; that, indeed, we have here the mechanism by which the carbohydrate is brought into a suitable form for combination with nitrogenous and other compounds? However this may be, before we can hope to present a picture of the relation between respiration and vital syntheses, we need not only many more data regarding respiration rates under both aerobic and anaerobic conditions, but also a detailed biochemical analysis of the carbohydrate and various nitrogenous materials present in a wide variety of tissues. So expressed, this may sound a simple enough matter, but actually, as anyone who has attempted to tackle such problems knows, it is one that abounds in difficulties.

While it has generally been assumed that respiration is linked in some unknown way with the synthesis of proteins and other substances, its connexion with those other processes, the absorption and excretion of materials which are characteristic of cells, has only come to be appreciated more recently. The absorption and excretion of water and dissolved substances was generally more or less tacitly assumed to be determined by the physical laws of osmosis and diffusion. Water was supposed to diffuse into or out of the vacuole according to the difference between the osmotic pressure of the cell sap and the sum of the osmotic pressure of the external solution and the inwardly directed pressure of the stretched and elastic cell wall. Dissolved substances were supposed to enter the vacuole according to the laws of diffusion expounded by Graham and Fick more than eighty years ago.

Although Collander's work on the absorption of a number of non-electrolytes indicates that this assumption may, in the case of such substances, be quite justified, it has been known now for thirty years that the entry of electrolytes into cells cannot be explained as the simple diffusion of a substance through a membrane from a region of higher concentration to one of lower concentration. During the years 1909–19, two facts militating against this simple view became established. In the first place, it was shown that the two ions of a salt could be absorbed by plant tissue at different rates, while in the second place it was shown that absorption of a salt or its ions takes place towards a condition of equilibrium which is not that of equality of concentration attained inside and outside the cell, but which depends on the concentration of the salt. With dilute solutions the concentration attained inside the cell may be many times that of the solution outside, while in concentrated solutions the reverse is the case and the concentration of the salt inside, even after forty-eight hours' immersion of the tissue in the solution, may be very much less than that outside. Thus, while more salt is actually absorbed from a stronger solution than from a weaker one, the absorption relative to the concentration is less, both as regards rate and total amount, from a stronger than from a weaker solution.

Various possible mechanisms have been suggested to explain this relation between concentration and absorption. When this problem was first investigated by F. Kidd and myself, we found that the relationship between concentration of salt and absorption was much the same as it would have been if the salt were adsorbed by an adsorbent within the cell. It is easy to suggest that a first stage in the absorption of salts by plant cells is the adsorption of the ions of the salt by some constituent or constituents of the protoplasm. While I have pointed out the similarity of the absorption of salts by plant cells with an adsorption phenomenon, I have more than once stressed the point that this similarity is in itself not sufficient to justify the advocacy of an adsorption theory of salt absorption. Yet it must be admitted that later work by more exact methods has only served to confirm the approximate similarity of the relationship between salt absorption and adsorption. Reference in this connexion may be made to the work of Laine on the absorption of manganese and thallium by roots of *Phaseolus multiflorus*, as well as to observations of my own on the absorption of sodium chloride by carrot root.

Of course, if the similarity between the relationship of salt absorption to concentration and the adsorption equation is more than a coincidence, adsorption can only be the first stage in this absorption, at any rate by actively growing tissues in which the absorbed ions must be transferred elsewhere. Again, one would expect the adsorbing material to be present in the protoplasm, whereas a number of more recent observations by various investigators indicate that there is actually an increase in concentration of the absorbed ion in the vacuole. The adsorption would then have to be followed by elution of the salt at the surface of the vacuole. In this connexion it is interesting to note that S. C. Brooks has obtained some evidence that *Valonia*, immersed in sea-water containing rubidium chloride, accumulates rubidium in the protoplasm for two days, after which this cation passes from the protoplasm to both vacuole and external solution. The same worker has also found that when cells of *Nitella* are placed in

0·01 *M* solutions of radioactive potassium chloride, there is an accumulation of potassium in the protoplasm after six hours, before any appreciable amount of potassium appears in the vacuole. Previously, M. M. Brooks had found that when *Valonia* is immersed in a solution of methylene blue, the cell wall and protoplasm become deeply stained by the dye before any appreciable coloration of the vacuole is observable.

Another mechanism which has been suggested as possibly operative in the absorption of salts is one of interchange of ions within and without the cell under conditions which give rise to the ionic distribution between the cell interior and exterior characteristic of what is called Donnan equilibrium; and in this connexion it must be emphasized that just as adsorption must take place if the cell contains adsorbents of ions capable of reaching the adsorbent, so, if the cell system involves the conditions giving rise to Donnan equilibrium, it is inevitable that the movement of ions demanded by these conditions must result.

The possibility that respiration has a direct effect in bringing about the absorption of ions has been pointed out by several workers, notably by Briggs and S. C. Brooks. The production of carbon dioxide in the cell leads to the appearance of carbonic acid, and hence of its ions, hydrogen and bicarbonate (H and HCO_3). The interchange of ions required by the Donnan equilibrium will lead to the diffusion out of hydrogen ions, which are replaced by cations from the external medium, while bicarbonate ions will be exchanged for anions from the external medium. As the tissue continually respires, the production of hydrogen ions continues to replace those which diffuse into the external solution, and so the absorption of ions continues as part of an interchange between tissue and external medium.

Against the view of a direct effect of respiration on salt intake by ionic exchange, it has been urged by Hoagland and Steward that accumulation of ions is negligible or slight when tissue is deprived of oxygen, although there may be a considerable anaerobic production of carbon dioxide. But as regards this objection it must be noted that under conditions of anaerobiosis the rate of carbon dioxide production usually falls rapidly with time, so that it is doubtful whether a considerable production of carbon dioxide anaerobically generally continues for any length of time. The question is obviously one requiring further experimental investigation.

That the absorption of salts by tissues is related to a supply of oxygen, and probably in some way to respiration, there can, however, be no doubt. For more than thirty years it has been known that the growth of plants in water-culture is often accelerated by aerating the solutions, while more direct evidence of the effect of oxygen on the salt relations of cells has been obtained in work with storage tissues. In 1927, I pointed out the importance of maintaining the supply of oxygen to such tissues for the maintenance of their vitality, and that in the absence of an adequate oxygen supply exosmosis of electrolytes took place, leading to the speedy death of the tissues; whereas with maintenance of a supply of oxygen, absorption of electrolytes continued, in the case of beetroot, for example, for periods of about three weeks. Towards the end of this time a condition of equilibrium was reached or approached, in which the content of electrolytes in the external liquid was very low. During this period conditions leading to lower oxygen and higher carbon dioxide concentration led to increase in the electrolyte content of the liquid, while addition of fresh oxygen led to a decrease.

In similar experiments carried out by Briggs and Petrie in 1931, in which a continuous stream of air was passed through the liquid, these workers examined the course of respiration along with the changes in electrolyte content of the external solution, and established the fact that there is a general parallelism between the rate of respiration of the tissue and the electrolyte concentration of the external liquid. If the stream of air was replaced by nitrogen the respiration rate increased, and so did the concentration of electrolytes in the solution, while replacement of the nitrogen by air brought back the original distribution of electrolytes between tissue and external liquid. Steward and collaborators have shown that reduction of the oxygen supply to storage tissue of potato, carrot and artichoke below a certain value limits the accumulation of both the ions of potassium bromide by the tissues, while Hoagland and Broyer have obtained a similar result with barley root systems.

In attempting to explain this effect of oxygen, one must bear in mind that the relationship between respiration and salt accumulation may not be a direct one. The maintenance of an adequate supply of oxygen is necessary to maintain the vitality of the tissue, possibly on account of the deleterious effects of the products of anaerobic respiration. Thus the fact that accumulation depends on oxygen supply may be regarded as an expression of the fact that under conditions of partial or complete anaerobiosis, the functioning of all or many vital processes dependent on the protoplasm is adversely affected, and along with them that of salt accumulation. From this point of view the effect of conditions leading to poor oxygen supply may be related not only to oxygen concentration, but also to accumulation of carbon

dioxide and other products of anaerobic respiration.

From a consideration of all the data, it seems to me that the following conclusion can be drawn regarding the relationship of respiration to the absorption of salts by plant cells, namely, that accumulation of salt depends on the vitality of the cells and that the maintenance of this vitality depends, as has been long recognized, on the presence of oxygen, either because aerobic respiration or some other process requiring oxygen is essential for this maintenance of vitality, or because in the absence of oxygen the accumulation of carbon dioxide and other products of anaerobic respiration adversely affects the functioning of the protoplasm. This dependence of absorption of salts on the vitality or healthiness of the tissue was clearly shown by my experiments of 1927, and by the later ones of Steward in which stress was laid on the effect of aeration of the tissues. I think Hoagland's observations on the effect of light on absorption of potassium bromide by *Nitella* fall into line with these. It was found that absorption of bromide only took place if the cells were exposed to light, or if they had previously been exposed to adequate illumination. If for some time previously they had been growing in weak light, no accumulation of ions took place. *Nitella* kept for some time in low light is probably somewhat unhealthy, just as is tissue that is deprived of an adequate supply of oxygen. In other words, most of the work published on the relationship between respiration and salt accumulation does no more than show that this accumulation is a vital process, depending on the normal functioning of the protoplasm. Any general relationship between respiration and salt accumulation, as regards the linkage of reactions involved, or the transfer of the energy required for the entry of a salt against its own diffusion gradient, may thus be very indirect.

Thirty years ago, when the importance of the principles of chemical dynamics in life processes was coming to be fully realized, it looked as if the solution of many of the problems of plant physiology, in terms of physical chemistry, was fairly imminent. But with the application of these principles to our investigations into living processes, we find that in every one of them the protoplasm introduces a factor which renders these processes not readily explicable in this way. Clearly we must seek an explanation in the apparent divergence of vital processes from physical or chemical laws in the constitution of the protoplasmic system, and hence a fuller analysis of this system now appears to be a requisite for further advance in our understanding of physiological processes in general. There is at present no reason to suppose that with further advance in knowledge of the protoplasmic system, we shall not ultimately be able to explain physiological processes in physico-chemical terms, and I would re-affirm what F. F. Blackman emphasized in his presidential address to Section K thirty years ago, namely, "the inevitableness of physical-chemical principles in the cell".

It is scarcely necessary to emphasize how the principles of general cell physiology must be of fundamental importance in plant metabolism, for inasmuch as this depends on the activity of specialized cells and tissues, these, wherever they are alive, must also exhibit the normal features characteristic of protoplasmic activity. But in spheres of botanical science outside the range of pure physiology, the general physiology of the cell is just as important. This applies in particular to ecology. This study, in so far as its aim is the determination of the relationship of plants to their environment, is indeed nothing else than physiology, a fact which was clearly recognized by Clements more than thirty years ago.

Of the two groups of factors which determine the distribution of vegetation, the climatic and edaphic, the mode of action of the latter in particular can only be studied with any hope of success by those with an adequately deep knowledge and appreciation of cell physiology. It does not need a knowledge of physiology, it is true, to determine plant distribution, but such knowledge is essential for what Tansley, in a paper read to Section K thirty-four years ago, called "the higher branch of ecology, i.e., the detailed investigation of the functional relations of plant associations to their surroundings". However desirable and necessary the collation of knowledge of plant distribution may be, I am certain that the solution of the fundamental problems of ecology will only be achieved by the use of physiological methods, and particularly by the application of our knowledge of the general physiology of the cell. For edaphic factors must act through the root and by the absorption of materials from the soil, or the exchange of material between the soil and root.

Certain aspects of mycology have much in common with physiology; indeed, that part of mycology which concerns pathogenic organisms is inevitably closely linked with problems of the relation of host and parasite, problems which are, in their very essence, physiological. Years ago it was questioned whether the physiology of the plant physiologists was not half pathology. Certainly the reverse question can be answered with more assurance; pathology is at least partly physiology, and therefore the principles of general cell physiology must here also be of immense importance, and an intimate acquaintance with

these principles should be an important part of the equipment of the plant pathologist.

Perhaps no branch of botany has made such spectacular advances in recent years as that of cyto-genetics. At least it has produced a nomenclature which rivals or excels the early efforts of the descriptive ecologists; and just as descriptive ecology can do little more than correlate certain types of vegetation with certain environments, so cytology can do little more than correlate visible structures in the cell with genetical behaviour. I cannot help thinking that a real insight into these problems also will only come with the interpretation of cytological observations in physiological terms, and that the greatest advance in the study of cytology will come with the linking up of the knowledge of the cell acquired by these two lines of investigation, the cytological and physiological. It is surely a rather remarkable fact—one indicating how far away we are at present from the achievement of this end—that the physiologist tends to think of the cytoplasm as the essential factor in determining vital activities, while the cytologist concerns himself almost exclusively with the nucleus. Neither the physiologist nor the cytologist appears at present to have anything but the vaguest ideas of the relationship between the two, a relationship which, however, we may feel sure is most intimate and fundamental to life.

We all know, but it cannot be too strongly emphasized, that botany is the pure science of a great part of the most important industry of the world, agriculture, and that this, like every other industry, can only be carried on wisely if its practice is based on scientific principles. Almost all branches of botany are important for agriculture; but mycology, genetics, and physiology are particularly so, and certainly physiology is not the least of these. Absorption of water and nutrients from the soil, assimilation of carbon, water relations of the plant, vegetative development, flowering and fruiting, are all problems of agriculture and forestry which are essentially physiological.

But besides these more obvious economic applications, there are numerous industries in which the principles of general cell physiology are no less fundamental. There are all those industries, ever increasing in number and importance, which are based on some particular plant product, such as cotton, linen, jute, rubber, tea, sugar and tobacco, to mention only a few of the more important. Apart from the growing of the plants themselves, which like any other form of agricultural practice should be based on sound physiological principles, a knowledge of these principles may be equally important in the subsequent treatment of the plant material. In particular, a knowledge of cell organization, the action of enzymes contained in the cell, its behaviour towards various reagents, all aspects of general physiology, is essential. Finally, the great food storage industry depends greatly on the application of knowledge of cell physiology. As an example of this I may refer to pioneer work on the scientific principles of cold storage by Jørgensen and myself carried out some twenty years ago. From a consideration of what was then known of the constitution of the cell, we concluded that the satisfactory preservation of certain tissues in the frozen condition depended on rapidly freezing the tissues, a method which was afterwards put into practice in certain branches of the food storage industry. This is, of course, only one instance of the bearing of general cell physiology on the subject of food preservation. The effect of the conditions of storage on enzymes and other cell constituents, and on the vitality of different kinds of cells, tissues and organisms are among the problems which a knowledge of the facts and methods of general cell physiology will help to solve.

With the ever-increasing mass of knowledge in the various branches of botany, an increase which is especially noticeable to-day in those aspects of our subject which are undergoing rapid development, namely, physiology, mycology and genetics with cytology, it is impossible for anyone to be an active worker in more than a relatively very small field of botanical endeavour. We sometimes meet with reference to a mysterious gentleman called the 'general botanist' who is expert in general botany, as someone distinct from the morphologist, physiologist, mycologist or other worker in a defined field. But in these days, when to make any contribution to knowledge necessitates specialization, there can indeed be no such person as the expert in 'general botany', for there is, indeed, no such subject. But in whatever part of our subject our own special interests may lie, we can still appreciate the efforts and aims of workers in other fields, and realize the bearing of work in these fields on our own problems, and in this sense we are all general botanists; that is, just botanists.

For if 'general botany' as something distinct from 'botany' is a myth, there is no doubt that the various branches of our subject are related in the whole. I have here tried to indicate not only the scope and present position of our knowledge of the general physiology of the cell, but also where this particular part of the science of plants comes into contact with other branches of botany, and how the application of a knowledge of the facts, principles and methods of cell physiology may be expected to lead to an increase in knowledge, not only of the physiology of the plant, but also of other aspects of botanical science and of its industrial applications.

The Perkin Tradition

DURING the Easter holidays of 1856, a young man of eighteen years of age was experimenting at home in Shadwell in chemistry. He followed up the coloured product of the reaction instead of chasing after a more orthodox crystal line substance and, strangest of all, had the curiosity to try to dye silk with it. A mauve skein resulted, and the aniline dye industry was born!

Perkin's father was a builder, and, looking back, he must have been a man of remarkable character. Not only did the son 'experiment' at a very youthful age, as in those halcyon days was customary, but also he seems to have been encouraged to try his hand in many directions, until finally, between twelve and thirteen years of age, he came to chemistry and to Thomas Hall at the City of London School. He next sought to go to the Royal College of Science: this was going a little too fast for the father, for chemistry was scarcely a profession in those days, but, with Hall's assistance, the young Perkin had his way and was allowed to study under Hofmann.

Mauve was discovered at home, and perhaps its properties received more discussion in the family circle than they would have done in a laboratory. In any event, Perkin there and then started to make his dye, while his father risked most of the capital which he had accumulated by a life of great industry to build and start the works. There can be no more outstanding example of confidence in a young son and paternal enterprise. Such a thing is utterly impossible to-day in any country; the name of George Fowler Perkin should be highly honoured by posterity.

W. H. Perkin was fortunate in another way; there was no school certificate or matriculation examination to dominate his education. What is the use of trying to turn out all the boys to-day in a common mould when we are really every one of us different: the examination system destroys any chance of incipient genius and is the negation of education, scientific or otherwise. Perkin would have probably passed his examination, but the preparation for it would have left him no time to express his individuality. Surely this is the chief lesson to be drawn at the time of celebrating the centenary of his birth.

The call to invent, to prosecute research, is strongly hereditary, though perhaps latent in the founder of the family. Sir William passed it on to all three sons, particularly to W. H. junior, and it is a loss to science that there has been no third generation.

The story of the Perkin adventure has been often told, in the greatest detail and from many aspects, particularly in relation to the rise and fall of the industry in England, its transference to Germany and its more recent resurrection here. The jubilee of the discovery in 1856 gave the chemical world an opportunity to honour Perkin. The centenary of his birth was celebrated on November 24 last by a memorial lecture given by Dr. Herbert Levinstein in the hall of the Leathersellers' Company, and arranged by the Society of Chemical Industry and the Chemical Society. The selection of speaker was a happy one; Levinstein's father maintained a dye industry in Great Britain during the darkest days of its difficulties, and father and son supplied a nucleus on which it was possible to condense other efforts when the upswing began. No more comprehensive, illuminating, balanced and graceful address has ever been forthcoming on this subject; the simplicity of its language makes it of wide appeal. The societies must give it full publicity; it should at least be read by every member of Parliament, to make them realize the significance of chemical effort for the benefit of man; perhaps educationists may be led to ponder also how they are going to preserve further Perkins for us and not destroy them in their teens.

Perkin's ability as an 'applied chemist' was remarkable. At an age when the young men of to-day are still playing games, he made discoveries in dyeing practice which Levinstein rightly regards as a more considerable achievement than the laboratory discovery of mauve. The new mauve dyed silk direct, but very irregularly: he found it dyed level shades if applied to silk in a soap bath, a novel method which has never since gone out of practice. Mauve would not dye cotton, far and away the most important textile fibre, without a mordant: Perkin, in 1857, when he was nineteen years of age, discovered the tannin method, since found of general application to basic colours. He did much also to make calico printing with the new dyes possible.

Perkin only remained seventeen years in industry, selling out when he was thirty-five years old; he had amassed what was for him in those days a competence. In so doing he displayed great shrewdness, as after events disclosed, in leaving the industry when it was in a very flourishing condition. In later life he showed relatively little interest in the industry, and some have blamed him for cutting himself so soon adrift from his own

offspring. The business side of the factory was looked after by his brother Thomas.

The rest of Perkin's life was devoted to pure research. He has himself told us that he determined not to let the manufacturing career check his scientific life. It is not at first glance easy to understand why he could be happy in the study of such subjects as magnetic rotation. To quote Levinstein, "this physicochemical work is of great difficulty but I should have thought of quite exceptional dullness for a man who had created vast industries."

I saw a good deal of Perkin in this last phase of his life, when it was hard to believe he had been so active as a young man. Most of us, like my own father, carry on such activity until incapacitated: the contrast between Perkin and Duisberg of the I.G. at the same advanced age was a remarkable one. Perkin followed a rigid and austere vegetarian diet, and it may be that it contributed in some way yet to be discovered to this change of outlook. But he was by disposition a man of most retiring nature.

It is the duty of the chemical societies to keep the memory of Perkin from fading from the public mind. His achievements were startling and will be remembered when the names of the statesmen of to-day are long forgotten. There is a great tradition to be kept alive.

"A crown of fame! Fulfilment of thy work well done,
And knowledge of a people's gratefulness."

E. F. A.

Obituary Notices

Sir Henry Fowler, K.B.E.

HENRY FOWLER, who died on October 16, at the age of sixty-eight years, was born at Evesham on July 29, 1870. His technical education started at the Mason Science College, Birmingham, and was continued at the Railway Mechanic's Institute at Horwich during his apprenticeship in the locomotive works of the Lancashire and Yorkshire Railway. Whilst at Horwich, Fowler gained the first Whitworth Exhibition to be awarded to a student of the Institute. After service under Sir John Aspinall, with whom he was associated in a series of classic experiments on train resistance, Fowler left Horwich to become gas engineer of the Midland Railway at Derby, where, a few years later, he became works manager of the locomotive works, under R. M. Deeley, whom he eventually succeeded as chief mechanical engineer in 1909. During the Great War, Fowler successively held the positions of director of production, Ministry of Munitions; superintendent of the Royal Aircraft Factory, Farnborough; and assistant director-general of aircraft production, Ministry of Munitions; for these services he was created C.B.E. in 1917 and K.B.E. in 1918.

Consequent upon the amalgamation of the railways of Great Britain in 1923, Fowler was appointed deputy chief mechanical engineer, and two years later he succeeded George Hughes as chief mechanical engineer of the L.M.S. Railway. From January 1931 until December 1932 he was assistant to the vice-president, and during these two years he was able to devote the whole of his energies to research and development, unhampered by the large volume of administrative work inseparable from his earlier appointments.

Although responsible for the design of several new locomotive types including the well-known "Royal Scot" class, perhaps Fowler's greatest flair was for works' organization. He also realized the vast economies that could be attained by the standardization of locomotive parts, and he was an early and successful exponent of the policy of reducing the number of different types of locomotive to a minimum.

Fowler was always an enthusiastic participator in the activities of the various institutions to which he belonged, and he ultimately became president of the Institution of Mechanical Engineers, the Institute of Locomotive Engineers, the Institution of Automobile Engineers and the Institute of Metals. His keenness in furthering the interests of such bodies was coupled with a deep sense of the importance of technical education and scientific research to industry. He did a great deal to facilitate the higher technical education of the many apprentices and pupils who passed through the Derby works during his time, and he was always ready to give up his leisure to address educational and scientific bodies, and to give freely of his accumulated experience.

Of Fowler's scientific work it is difficult to speak fairly. He had no time for carrying out personally many of the investigations which he, often before his colleagues, saw were necessary; but he had an extraordinary gift of encouraging others, both within and without the railway service, to follow the lines he had indicated: and he was always most generous in providing facilities for trying out other people's ideas. In all this work he maintained an almost boyish enthusiasm, and was never happier than when he was able to spare the time to discuss the progress of some particular research with those who were actually conducting it. He was also skilful in securing the interest of eminent scientific workers in his locomotive and metallurgical problems, and he undoubtedly established for the former Midland Railway a reputation for sympathy towards scientific methods.

Fowler would probably have agreed that crank axles and boilers were the subjects that fascinated

him most, and his investigation into the life of the former was an almost classic example of the statistical use of a vast mass of metallurgical evidence. The many problems connected with the locomotive boiler also held a great appeal, and he could never resist the temptation to inspect personally any boiler that had developed some peculiar defect in service. Even on his many visits abroad, he invariably took his boiler-suit with him and excited the admiration of his hosts (and of the writer) by his skill in negotiating the not always easy entrance to the barrel or firebox of a locomotive. Therein he showed how thoroughly he understood the value of personal observation, which is so essential in engineering and metallurgical research. T. M. H.

Prof. P. A. Murphy

PAUL ALOYSIUS MURPHY, whose death at the age of fifty-one years occurred on September 27, was born in Co. Kilkenny. After courses at the Albert Agricultural College, Glasnevin, and the Royal College of Science, Dublin, extending over five years, he was appointed to a temporary post under the Irish Department of Agriculture and started research in plant pathology. Later, with a Development Commission scholarship, he proceeded to the Imperial College of Science and Technology, London, and to the K. Biologische Reichsanstalt, in Berlin-Dahlem. Leaving Germany in 1914, and being rejected on medical grounds for active service, he completed his scholarship period at Cornell University. He was then appointed plant pathologist in Prince Edward Island by the Canadian Government. He returned to Ireland in 1921 to similar work in the Department of Agriculture there, and six years later was appointed to the newly created chair of plant pathology in University College, Dublin, which he held until his death.

Murphy's scientific work was very largely concerned with research on potato diseases. After having helped to show the bacterial nature of the so-called 'black leg' disease and to prove that the blight fungus (*Phytophthora infestans*) was capable of producing sexual spores—a much-vexed problem up to that time—he worked out the cytology of the peculiar mode of sexual reproduction in the newly discovered allied species *P. erythroseptica*. Later, he considerably extended his work on the bionomics of *P. infestans*, but devoted much attention to virus diseases such as leaf roll, mosaic, crinkle and streak. His contributions to a scientific knowledge of these obscure diseases were particularly extensive and important, and received world-wide recognition. As a result of his investigations and those of a few other pioneers, the production of healthy stocks of potatoes has been placed on a sound scientific basis, and important advantages to practical agriculture have already accrued. To mark his eminent work in the sphere of potato husbandry, Murphy was awarded the John Snell Memorial Medal by the National Institute of Agricultural Botany in 1927.

At his old college at Glasnevin (now incorporated with University College, Dublin) Murphy developed a vigorous school of plant pathology, and the sound work of himself and his colleagues there, not only on virus diseases but also on others, such as onion mildew, swede dry rot, sugar-beet crown rot and American gooseberry mildew, is a testimony to its wide scope and to Murphy's inspiring and untiring devotion to research in plant pathology.

Murphy graduated at the University of Dublin (Trinity College) in his student days and was awarded the Sc.D. degree in 1922. He was a member of the Royal Dublin Society and a valued member of its Science Committee. For his published researches, the Society awarded him the Boyle Medal in 1933, and at the time of his death these were approaching fifty in number. He was also a member of the Royal Irish Academy, of the Phytopathological Society of America and of the Agricultural Research Council's Committee on Virus Diseases of Plants.

Murphy's loss will be deplored in wide circles, for he was always ready to help other workers. Many of them, both at home and abroad, will gratefully remember his generosity in the distribution of strictly dependable material—the product of his own careful and protracted work—which greatly facilitated their own investigations. He leaves a widow and two sons, for whom the deepest sympathy is felt.

G. H. P.

MR. ROSSE BUTTERFIELD, of High Cote, Riddlesden, Yorkshire, curator of the Keighley (Yorkshire) Corporation Museum, who died recently at the age of sixty-four years, was a well-known naturalist of the West Riding. He came of a Wilsden family of naturalists and his father was a well-known authority; another member of the family was the late Mr. Ruskin Butterfield, formerly curator of the Hastings Museum. Mr. Rosse Butterfield did much valuable work in connexion with organizations of naturalists, and he was himself known for his work in entomology. He had been the curator at Keighley Museum since 1910 and was due to retire next year. Under his guidance the development of the Museum collections and of education in natural history has made rapid strides. He was a member of the executive of the Yorkshire Naturalists' Union and was secretary of the Keighley Naturalist Society. He was a member of the committee of the Bradford Natural History and Microscopical Society and was recorder for Hymenoptera. Formerly, Mr. Butterfield was curator of the Bronte Museum at Haworth.

WE regret to announce the following deaths:

Sir James Barr, C.B.E., consulting physician to the Liverpool Royal Infirmary, known for his work on the diseases of the blood vascular system, on November 16, aged eighty-nine years.

Prof. J. W. Bews, principal of Natal University College and professor of botany in the College, aged fifty-three years.

Prof. William McDougall, F.R.S., professor of psychology in Duke University, North Carolina, aged sixty-seven years.

News and Views

Dr. G. S. Whitby

As announced in NATURE of November 5, p. 828, Dr. George Stafford Whitby, for the past nine years director of the Division of Chemistry, National Research Council of Canada, has been appointed director of the Chemical Research Laboratory of the Department of Scientific and Industrial Research, London. In Canada, Dr. Whitby has organized and directed chemical research in many lines, not a few leading to industrial applications and developments. At the age of sixteen years, he entered the Imperial College of Science and Technology, London, where he worked under Sir William Tilden. Following graduation, he spent four years on the staff of the Imperial College in teaching and research under Sir Edward Thorpe. He then spent seven years in the East Indies as chief chemist to a group of British, French and Belgian rubber companies. His work there had a marked influence on the development of the rubber industry, and established him as one of the leading rubber chemists of the world. He was appointed assistant professor of organic chemistry in McGill University in 1918, and eventually associate professor and full professor. Dr. Whitby has published seventy-seven scientific papers, chiefly in the realms of organic and colloid chemistry. In 1929, he was selected to take charge of the Division of Chemistry of the National Research Laboratories, Canada. Many of the research programmes initiated by him have yielded results of commercial value, notable examples being the development of refractories, improvement of testing methods and means for the utilization of asbestos, the application of research to the problems of laundering, the development of processes for the utilization of waste natural gas, studies in wool, leather, rubber and other materials of commerce.

Prof. J. Plotnikow

PROF. J. PLOTNIKOW, director of the Physico-Chemical Institute in the technical faculty of the University of Zagreb (Jugoslavia), will celebrate his sixtieth birthday on December 4. Prof. Plotnikow is very well known for his numerous investigations in photochemistry and photography, and for various books, amongst which may be mentioned "Photochemische Versuchstechnik" (2nd edition, 1928, Akademische Verlagsgesellschaft, Leipzig); "Grundriss der Photochemie" (1923, W. de Gruyter, Berlin); "Photochemie für Mediziner" (1928, G. Thieme, Leipzig); and "Lehrbuch der allgemeinen Photochemie" (2nd edition, 1936, W. de Gruyter, Berlin). He was born at Tambow, Russia, was a student of physics and mathematics at the University of Moscow until 1901, and from 1901 until 1908 worked in Ostwald's Institute at Leipzig, in which he was appointed assistant in 1906. Returning to Moscow, he became professor in 1916, but lost his position, his property, and very nearly his life in the Russian revolution. After a year as director of the scientific laboratory of the "Agfa" Company (Berlin), he became in 1920 a professor at Zagreb. For his discovery of 'infra-red shadow photography' he received the 'Goldene Verdienstmedaille' of the Vienna Photographic Society.

Prof. A. Sommerfeld

PROF. ARNOLD SOMMERFELD, professor of theoretical physics in the University of Munich, will celebrate his seventieth birthday on December 5. He is able to look back on a long and successful career in mathematical physics, both in research and in teaching. During the time of his tenure of the chair in Munich, where he succeeded Boltzmann in 1905, his modest institute became the centre for students of physical theory, many of whom went there from abroad for a period under his inspired guidance. Among his numerous pupils who now occupy high positions in the academic world, Debye, Pauli and Heisenberg may be mentioned.

Social and International Relations of Science

THE British Association has now constituted a committee to work the Division for the Social and International Relations of Science which was established at the recent meeting of the Association in Cambridge. The committee, under the chairmanship of Sir Richard Gregory, includes the president and general officers of the Association *ex-officio*, Sir Daniel Hall, Sir Frederick Gowland Hopkins, Sir John Russell, and Lord Stamp as vice-chairmen, and as other members: Prof. F. C. Bartlett, Prof. J. D. Bernal, Prof. P. M. S. Blackett, Mr. Ritchie Calder, Mr. A. M. Carr-Saunders, Prof. S. Chapman, Dr. C. H. Desch, Prof. A. C. G. Egerton, Prof. H. J. Fleure, Mr. E. W. Gilbert, Prof. N. F. Hall, Mr. R. F. Harrod, Prof. A. V. Hill, Sir Clement Hindley, Prof. L. Hogben, Dr. L. E. C. Hughes, Dr. J. S. Huxley, Mr. D. Caradog Jones, Prof. H. Levy, Dr. C. S. Myers, Mr. Max Nicholson, Sir John Orr, Prof. J. C. Philip, Prof. J. G. Smith, Prof. R. G. Stapledon, Prof. F. J. M. Stratton, Prof. F. E. Weiss, Mr. H. G. Wells, Mr. J. S. Wilson, Dr. S. Zuckerman. The main purposes of the Division are stated to be "the objective study of the effects of advances in science on communities, and reciprocally the effects of social conditions upon the progress of science; and the encouragement of the application of science to promote the well-being of society".

THE committee is empowered to arrange meetings of the Division, to co-ordinate work dealing with the social relations of science, both at home and abroad, to be prepared to act in a consultative capacity and to supply information to organizations, individuals, and the public, to initiate and carry out inquiries and research, and to secure their publication. An executive sub-committee has prepared an extensive programme of work for the full committee, which, at a meeting on November 28, appointed a number of other sub-committees to deal with specific matters. These include such topics as the economic requirements of nations, the influence of scientific and technical developments on the relative importance of different industries and on the total volume of employment, the question of supplementing existing national research organizations whether in normal circumstances or at time of emergency, and the co-ordination and subsequent public presentation of work on nutrition and agriculture. Contact has already been established with organizations at work on such subjects as a survey of research in Great Britain, the prospective effects of changes in the population structure on economics, society, and occupations, and the incidence of taxation on scientific research. It is hoped to co-operate with the International Council of Scientific Unions, which has already set up a Committee on Science and its Social Relations with the view of preparing a report of world-wide scope.

Jundhi Shapur

AT a meeting of the Section of the History of Medicine of the Royal Society of Medicine on November 2, Dr. Cyril Elgood gave an interesting account of Jundhi Shapur, which was famous as the site of a university in south-west Persia, probably founded about A.D. 340. The Arab invasion of Persia took place when Jundhi Shapur was at the height of its fame. The city surrendered in A.D. 636, but was left undisturbed, and the University remained the greatest centre of medical learning in the Islamic world until the foundation of the school of medicine in Bagdad. The system of medicine taught at Jundhi Shapur was predominantly Greek, but indigenous medicine, Indian medicine, and possibly Chinese medicine were also studied there. The teachers of Hippocratic medicine were reinforced by the exodus of the Nestorian professors from Edessa in 489 and of the Neo-Platonists from Athens in 529. There was also a constant flow of individual Greek physicians to the Persian royal service. The importance of Jundhi Shapur lay in its being a store-house of Greek tradition when Rome was no longer the capital of the Empire and when Constantinople was more interested in theology than in science. It was the cradle of the great Arabian school of medicine and provided most of the translators who rescued Greek texts from oblivion, thus forming the source of the renaissance of medicine in Europe. Owing, however, to the constant transfer of physicians to Bagdad, the school of Jundhi Shapur declined, and by the twelfth century ceased to function.

Awards of the Mary Kingsley Medal

PRESENTATIONS of the Mary Kingsley Medal to five recipients were made on November 23 at a reception at the Liverpool School of Tropical Medicine by its chairman, Viscount Leverhulme. This medal, struck in commemoration of the late Miss Mary Kingsley, niece of Charles Kingsley, distinguished for her work in promoting the welfare of the natives of West Africa, is awarded in recognition of services in the cause of fighting and preventing disease in the tropics. After the chairman had welcomed the guests, Prof. Warrington Yorke introduced the recipients of the medals, briefly outlining the grounds for the awards. They were: Lady Danson, honorary recipient, widow of the late Sir Francis Danson, who was Chairman of the Liverpool School over a lengthy period, and was largely responsible for the establishment of the School's research laboratory at Freetown, West Africa, and herself undertaking the duties of chairman during her husband's absences; Dr. Marshall A. Barber, with a long and distinguished association with the International Health Division of the Rockefeller Foundation, and recognized for his researches on malaria and for his work on the hook-worm, and inventor of the 'micromanipulator'; Prof. Emile Brumpt, of the University of Paris, distinguished for his researches on tropical parasitology; Prof. W. Scott Patton, emeritus professor of entomology in the School, formerly in the Indian Medical Service and director of the King Institute, Madras, well known for his researches on kala-azar and oriental sore, and finally Werner Schuleman, professor of pharmacology, University of Bonn, the discoverer of the anti-malarial drug, plasmoquine, which gave a great impetus to chemotherapy.

Early Anatolian Civilizations

MISS WINIFRED LAMB'S account of her third season of excavation at Kusuru, south-west of Afyon Karahissar in Anatolia, which was given before the Society of Antiquaries of London on November 17, emphasized the importance of this little-explored region for knowledge of the cultural distributions of Asia Minor in the third millennium B.C. Miss Lamb was able to demonstrate that at this early period the distinction which has been drawn between the cultures of eastern and western Anatolia is by no means so clearly defined as has been thought. The culture of the community of Kusuru in the third millennium, she finds, had much in common with that of the western Anatolian group; and she would regard the two, not indeed as dissociated, but rather as independent developments of the culture of peoples of a common stock. A relatively advanced stage of civic development is indicated by the disposition of the houses on either side of a street. These architectural remains are well preserved, and in some instances still rise to a height of more than three metres. A period of disturbances and the partial destruction of the settlement at about 2000 B.C. was followed by the appearance of a new race. The town was rebuilt and its citadel enclosed by a double wall with a gateway on the west. On the evidence of the pottery, implements and cult objects,

it is possible to conclude that this new people was identical with that which formed the bulk of the population of the chief Hittite centres at Boghazkoi, Alishar and Alaga. This is the first occasion on which this culture has been found so far to the south-west. Its presence here may be expected to throw light on the difficult ethnological and historical problems of the second millennium B.C.

Prehistoric Pottery in Kent

THE results of further excavations in the Bean Valley, Kent, upon which Mr. J. P. T. Burchell made a report before the Society of Antiquaries of London on November 24, have failed to support the suggestion that the pottery discovered here in a previous investigation was of palæolithic age (see NATURE, 140, 800; 1937.) The evidence upon which Mr. Burchell relied in making such a suggestion was in part the absence of a mesolithic culture in the lower beds of the series in which the pottery occurred, in part the presence in the deposits of shells of the extinct *Helicella striata*, not previously recognized later than the Upper Palæolithic. Mr. Burchell's further examination of the site leads him to agree with the dissentient opinion previously expressed that this pottery is to be assigned to the early bronze age. It has been shown by this season's excavation that *Helicella striata* outlived the last glacial phase and survived into the mesolithic period. What was thought to be collateral evidence from Springhead in the Ebbsfleet valley in the form of striated implements showing the effect of glacial action has now proved to be later in date than two mesolithic floors in the valley, and consequently some other explanation of their condition must be sought. The excavations in the Ebbsfleet valley in the course of this further investigation have been pursued in exceptionally favourable conditions owing to pumping operations. It was found possible to excavate the bed of the stream to a depth of ten feet, and remains of cooking pots, decorated within and without, of a type not previously found in Britain, with flint flakes and fragments of worked wood of late mesolithic dating, were found in a grey silt below ten feet of peat.

Electricity in Coal Mines

IN a paper read by Mr. R. Nelson to the Institution of Electrical Engineers on December 1, a retrospect is given of the use of electricity in coal mines during the last thirty years and also a forecast of what still remains to be done before the mines of Great Britain are fully electrified. In the year 1883, the first electric motor pump was used to pump water from a coal mine; it was only 1½ h.p., but there was then only very little mechanical power used for any purpose below ground. Twenty-five years ago the most disastrous explosion in the history of British mining, namely, that at Senghennydd Colliery, South Wales, had the effect of causing the miners to call for the removal of electricity from the pits. Happily, by the application of systematic stone dusting, a means was found of preventing the spread of an explosion of gas or coal-dust, and thereafter the miners' opposition lessened, at any rate in degree, but it has not yet disappeared. During the last ten years, the coal industry has been greatly assisted by mechanized mining and mechanical methods of coal sorting. These, with normal development in other directions, have resulted in a total of more than two million horse power of motors installed in 1937, half of them being below ground. Accident statistics are touched upon. It is recorded that, taken over ten years, 1927–1936 inclusive, electricity has been responsible for 224 out of 8,656 deaths, or 2½ per cent of the total loss of life in the pits. Electricity and compressed air are rival sources of power for the machine cutting of coal. In 1937 seventy per cent of the machine-cut coal was cut by electricity. It is satisfactory to learn that in some of the recently developed South Yorkshire and Nottinghamshire coalfields, their transmission mains are interconnected, a very desirable example of co-operative working. The wider provision of cheap and unlimited current, by the 'grid' for example, would facilitate the use of electricity for all colliery purposes, and would improve the economics of the coal industry by materially assisting mechanical mining. The author concludes with an appeal to electrical engineers to capture the confidence of the miners.

British Museum (Natural History): Acquisitions

MRS. MARY V. WALKER has presented to the Department of Zoology a set of photographs which were taken by her husband, the late Dr. William D. Walker, depicting the early life history of kangaroos. The photographs show the kangaroo in all its stages from the newly born young one to the adult and mature individual. The first of the series shows the newly born kangaroo having just made its way into the pouch and it is seen adhering to one of the nipples. At this stage the animal is very embryonic and bears but little resemblance to the massive creature into which it will grow, being scarcely more than an inch in length and looking more like a fragment of raw flesh than the young of any animal. A skin and seven skulls of a rare species of otter (*Paraonyx microdon*) have been presented by Mr. M. D. W. Jefferys. Mr. J. F. Perkins, assistant keeper in the Department of Entomology, spent six months from April until September 1938 in Sweden partly in the study of the important Thomson Collection of Ichneumonidæ (Hymenopterous insects the larvæ of which are parasitic on the larvæ of other insects), and partly in collecting insects, chiefly Ichneumonidæ, from the localities in Sweden where most of Thomson's specimens were obtained. More than 40,000 specimens of Hymenoptera were collected, of which 12,000 were Ichneumonidæ. A large quantity of the material obtained was identified and compared with the Thomson Collection before leaving Sweden, and the specimens so dealt with were found to represent 540 different species of which 260 were not previously to be found in the British Museum (Natural History). The collections obtained by Mr. Perkins constitute an important addition to the Entomological Department, and for the large number of specimens acquired and for the work done upon them in Sweden the Museum

is indebted not only to Mr. Perkins but also to his wife, who accompanied and assisted him. Recent acquisitions in the Geological Department include nearly 300 invertebrate fossils from the Tertiary of the West Indies, collected and presented by Dr. C. T. Trechmann.

THE Department of Botany has received the first consignment (2,800 specimens) of Dr. Carl Christensen's fern herbarium. Dr. Christensen is the chief authority on the taxonomy of ferns and is the author of "Index Filicum". It is estimated that the collection comprises more than 14,000 specimens with more than 800 types and 800 co-types, and in addition fragments of 900 types and co-types; also more than 4,000 drawings, photographs and figures. The herbarium is without doubt the most important collection of ferns in private hands, and will add enormously to the value of the important fern section in the Department. The original drawings (426) illustrating the late E. D. Heathcote's "Flowers of the Engadine" have been presented to the Department by his daughter, Mrs. D. Lee. A further 600 specimens of flowering plants collected by Dr. H. Smith in Western China have been purchased. These are well collected and preserved and contain several co-types. A collection of 984 lichens from northern Norway and from Baffin Land made by Dr. N. Polunin has been purchased. Although these are rather fragmentary owing to the difficulties of transport, the collections are important because they have been examined by experts and are the token specimens for several distribution records.

Wild-Life of North-West England

IN a lecture to the Blackburn Naturalists' Field Club on November 26, Mr. Eric Hardy mentioned that oyster-catchers, curlew, woodcock, redshank, tawny owls and spotted woodpeckers, are all increasing their nesting range in Lancashire and Cheshire, but the terns are becoming fewer at the well-known Ainsdale sea-bird sanctuary. His subject of "On My Rounds: Notes From a Naturalist's Notebook" described his field studies in Knowsley Park, where great crested grebes, sandpipers, kingfishers and goldcrests are all common nesters and winter wildfowl visiting the great lake are more numerous and varied than at any other Lancashire water; he also showed a series of Dufay natural colour photographs taken at London Zoo this year and some scenes from Whipsnade Zoo, while the small herd of Chartley wild cattle there was compared with photographs of the original herd at Chartley Park, Staffordshire, now extinct, but of which Mr. Hardy has two valuable photographs taken by a Liverpool naturalist in 1891 when the historic herd totalled 52 and tuberculosis had not then broken out. At the Liverpool Cathedral Wild Birds' Sanctuary, said Mr. Hardy, there is a resident population of a few blackbirds, greenfinches, song thrushes and wrens, but in winter chaffinches, great tits, cole tits and goldcrests visit it and during migration willow-warblers are frequently heard, despite the sanctuary being in an old cemetery in the midst of city slums. From this position inside the city, valuable migration and other observations have been made, as a refuting of the old belief of great migrations of city sparrows to distant harvest fields, but owing to the position of a new masons' shed directly above the sanctuary, it has not been possible to attract many birds this year although the sanctuary is to be reconditioned and improved.

Industrial Research in India

THE report of the Industrial Research Bureau, Government of India, for the year 1937–38 (Delhi: Manager of Publications), covers the activities of the Industrial Research Council, the Industrial Research Bureau, which has been placed on a permanent basis as from March 1, 1938, and of the Research Branch of the Government Test House in the third year of its working. Special attention has been devoted to the improvement of glass products and, in addition to the work in this field described in a separate chapter of the report, including the improvement of glass furnaces and a survey of glass-making materials, the Council has authorized further work with an improved type of pot furnace. The Research Branch of the Government Test House has been responsible for a considerable amount of work on paints, natural weathering and accelerated weathering tests and also on the construction and performance of dry cells. Work has also been carried out on the use of vegetable oils as fuels and as lubricants for internal combustion engines, and promising results have been obtained with β-naphthol, diphenylamine, acetylphenylhydrazine and tin naphthenate as antioxidants in blends of castor oil with mineral oils. Information on the manufacture of casein and casein plastics in India is being collected, and a number of investigations on oils and soaps have been allocated. The report includes particulars of publications of the Bureau and of inquiries received.

Research in Education in the United States

As a step toward canalizing research activities in the field of secondary education, much of which might otherwise run to waste, the United States Office of Education has published a bulletin on "Needed Research in Secondary Education" (Washington, D.C.: Supt. of Documents. Pp. 70. Price 10 c.). The bulletin is largely based on the monographs of the National Survey of Secondary Education, a collection of important research studies (more than 4,400 pages in all) relating to organization of schools, the pupil, administrative and supervisory problems and personnel, the curriculum and "the extra-curriculum". Before proceeding to indicate specific problems needing investigation, the author discusses some general characteristics of contemporary methods of educational research, distinguishing, for the purpose of evaluating results, three levels of quality: the study of the results of practices (1) in any and all schools as found; (2) in schools selected for their outstanding merit, and (3) in experimental conditions set up especially for

the purpose of testing theory. He emphasizes the need for more co-ordinated and co-operative research enterprises such as the college entrance inquiry, undertaken by the Progressive Education Association, into college entrance problems, in which three hundred colleges and thirty schools are participating. Indications of specific problems needing investigation are given under twenty-five headings, corresponding with the several survey monographs already referred to; for example, individual differences, guidance, interpreting the secondary school to the public, and the library.

CO-OPERATIVE educational research on an unprecedented scale was undertaken in 1936–37 by sixty universities in the United States under what was known as the Project in Research in Universities of the Office of Education. An important feature of the project was the widespread and co-ordinated attack on each of forty selected problems by a number of universities at the same time. The results of the investigations have been reported in a series of bulletins issued by the Office of Education. An interesting example of these is Bulletin No. 17 on "Opportunities for the Preparation of Teachers of Exceptional Children" (Washington, D.C.: Superintendent of Documents. Pp. 58. Price 10 c.). This gives a conspectus of courses concerning the education of eight different groups of exceptional children: blind, deaf, crippled, delicate, speech-defectives, mentally retarded, mentally gifted, and socially or emotionally maladjusted. In recent years such courses have been characterized by an increasing breadth of the pre-requisites for qualifying as a teacher of any one of these groups, candidates being required to have a general knowledge of the teaching methods appropriate for use with normal children and of the needs and problems of exceptional groups other than that chosen for special study. Of the courses concerning the education of exceptionally gifted children, the report notes that "so little is known to-day as to how gifted children should be educated that it is not surprising to find so few teacher-education institutions presuming to tell their students in any intensive way how to do it".

Suggested New Peace Conference

THE petition for the holding of a New Peace Conference open to all nations and directed towards remedying the economic and political conditions likely to lead to war, and urging the Government to take, in consultation with the President of the United States of America, the necessary steps to secure the holding of such a Conference, which has been sponsored by the National Peace Council, has received an excellent response. Requests for more than 100,000 petition forms have been received from national organizations, most of which will go to local organizations. The National Peace Council has also issued an appeal for the sum of £2,000 to liquidate an accumulated deficit and provide the expansion of income required for its growing work in mobilizing public opinion in Great Britain in support of efforts to lay the foundations of a general and durable peace.

Activity of the Leonids

MOHD. A. R. KHAN, Begumpet, Deccan, observed the Leonid shower this year on November 14–17, and found that it was more active than it has been for several years. On the night of November 15, in spite of the fact that the radiant was close to the moon, between $21^h\ 30^m$ and $22^h\ 30^m$ U.T., out of 31 meteors observed 14 were Leonids. Several of them were bright, the magnitudes in some cases being 0 or even brighter, and most of them were followed by expanding streaks. During the next half hour the numbers fell off, only two out of eleven meteors observed being Leonids. On the following night, between $21^h\ 5^m$ and $22^h\ 35^m$ U.T., out of 48 meteors observed, 12 were Leonids, but on November 17, only two Leonids were observed out of a total of eight meteors between $23^h\ 30^m$ and 24^h U.T. The Leonid shower has been rather feeble for some years, but this year it returned with surprising activity.

Another Large Sunspot

SUNSPOT frequency remains high, and large spots within the range of naked eye vision have averaged, so far this year, one new group in about every ten days. Very large spots, say of area greater than 1,000 millionths of the sun's hemisphere, have been well represented, no fewer than thirteen having been recorded during the eleven months of 1938. A group of spots, first seen near the sun's east limb on November 23 in solar latitude 14° north, grew rapidly in the next few days from 150 millionths to 1,950 millionths by November 27. The date of central meridian passage of this large group was November 28·8, and the west limb will be reached on December 5. On December 6, a region of the sun containing another large spot, which was developing during its approach to the west limb, will come into view again at the east limb.

Announcements

THE Buchan Prize for 1939 of the Royal Meteorological Society has been awarded to Dr. E. W. Hewson, for papers contributed to the *Quarterly Journal* of the Society during the years 1933–37 dealing with "The Application of Wet-Bulb Potential Temperature to Air Mass Analysis".

THE following officers for the session 1938–39 of the University of Durham Philosophical Society have recently been elected: *President*, Very Rev. C. A. Alington; *Hon. General Secretary*, Dr. W. A. Clark; *Hon. Treasurer*, Mr. J. W. Bullerwell; *Editor*, Prof. G. W. Todd.

AN exhibition of optical aids will be held in Barnsley Grammar School on December 10. During the afternoon, Mr. H. S. Magnay, director of education, Barnsley, will speak on "The Work of the British Film Institute". Further information can be obtained from the Exhibition Secretary at the Grammar School.

DR. EUGEN KORSCHELT, emeritus professor of zoology and comparative anatomy in the University of Marburg, has been awarded the Goethe medal for art and science.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 1000.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Further Evidence for the Radioactive Decay of Mesotrons

IT has been shown recently by Euler and Heisenberg[1,2] that the postulate that heavy electrons (or mesotrons as they seem to be finally named) are radioactively unstable, with a mean time of decay when at rest of about 2×10^{-6} seconds, is capable of explaining quantitatively the greater apparent absorption of penetrating cosmic rays in air than in dense materials.

Exactly the same considerations serve to explain the observations of Auger, Ehrenfest, Freon and Fournier[3], who measured the zenith angle distribution of the penetrating rays at different altitudes above sea-level, and found that the absorption of the inclined rays was greater than that of vertical rays under the same thickness of absorber.

Assume an isothermal atmosphere, so that the pressure will vary with the height z as $\exp(-z/z_0)$, where z_0 defines the rate of decrease of pressure with height. Let I_0 be the vertical intensity at sea-level, and let I_1 be the intensity at a height z_1, in such a direction θ_1 from the zenith that the total mass of absorber is the same, so that θ_1 is given by $\cos\theta_1 = \exp(-z_1/z_0)$.

Following Euler and Heisenberg, we suppose that the mesotrons are produced by the incident primary rays after the latter have traversed a thickness of absorber equivalent to a fraction $f \approx 1/10$ of the vertical thickness of the atmosphere. Then the rays coming vertically downwards will be produced at a height z_m given by $f = \exp(-z_m/z_0)$, and those inclined at an angle θ_1 will be produced at a height z'_m given by $f\cos\theta_1 = \exp(-z'_m/z_0)$. Since the vertical rays traverse a path of length z_m to reach sea-level, and the inclined rays a path $(z'_m - z_1)\sec\theta_1$, to reach the height z_1, the excess path traversed by the latter is $l = (z'_m - z_1)\sec\theta - z_m$. The relative intensity of the inclined rays to the vertical rays is then $I_1/I_0 = \exp(-l/L)$, where L is the mean range of the mesotrons before decay. Using the expressions given above for l, z_m, z_m' and θ_1, we obtain:

$$\frac{I_1}{I_0} = \exp\left\{\frac{z_0}{L}(e^{z_1/z_0} - 1)\log f\right\}$$

From the meteorological data[7], we have $z_0 = 7{\cdot}0$ km., and assuming $f = 1/10$, corresponding to a height of formation of mesotrons of 16 km., we obtain, using the observed ratios of I_1/I_0 taken from the data of Johnson[4] and of Auger and others, the values of L given below.

Height	(I_1/I_0) obs.	L calc.	Observer.
1·9 km.	0·78	20 km.	Johnson
3·4 km.	0·69	25	Auger and others
		mean 23	

It has been further shown by Blackett[8] that the observed temperature coefficient α of cosmic rays can be explained as due to the greater vertical extension of a warm atmosphere, and should be given by the expression $\alpha = (dz/d\theta)/L$, where $dz/d\theta$ is the rate of increase with temperature of the layer of the atmosphere where the mesotrons are formed. Cosmic ray observations[6] give $\alpha = -0{\cdot}18$ per cent per °C. and the meteorological data[7] give $dz/d\theta = 45$ m. per °C. for a height of about 16 km. Thus we get $L = 25$ km., in close agreement with the value of 24 km. found above for rays of about the same energy.

Consider now the observations of the mass absorption anomaly between air and water. The observed intensity under 60 m. water is one half that at sea-level under the same mass of air, that is at an angle θ_1, such that $\sec\theta_1 = 6{\cdot}0$. The height of formation of the rays, calculated as above, is 28·6 km., and so the difference of path between the inclined and the vertical rays is $28{\cdot}6 \times 6 - 16 = 156$ km. This is the *half-value* range, giving a *mean* range $L = 156/0{\cdot}693 = 225$ km. The mean energy of the rays which penetrate 60 m. water can be estimated from the measured energy spectrum to be 3×10^{10} e.-volts, while the mean energy of the rays at sea-level is about 4×10^9 e.-volts.

We thus have two rough determinations of L for two different roughly estimated mean energies, $\bar{E}$.

Experiment	L	$\bar{E}$		$L/\bar{E}$
Mass absorption anomaly ..	km. 225	e.-volts 3×10^{10}		cm. (e.-volts)$^{-1}$ $7{\cdot}5 \times 10^{-9}$
Inclination anomaly ..	23	4×10^9	mean	$\frac{6 \times 10^{-9}}{6{\cdot}8 \times 10^{-9}}$
Temperature effect ..	25	24 km.		cm. (e.-volts)$^{-1}$

If τ and τ_0 are the decay times of a particle of mass μ when at rest and when moving with energy $E \gg \mu c^2$, we have, from relativity considerations,

$$L = c\tau = \tau_0 E/\mu c,$$

whence $L/E = \tau_0/\mu c = \text{constant}$. This is seen to be approximately the case, thus verifying approximately the change of time-scale of a moving particle.

The mean observed value of the constant gives $\tau_0/\mu = 1{\cdot}29 \times 10^{10}$ sec./gm.$^{-1}$. It is thus the ratio τ_0/μ that is given directly by such experiments. To get τ_0, the mass must be assumed. Taking $\mu = 150\ m_e$, we get $\tau_0 = 1{\cdot}7 \times 10^{-6}$ sec.

P. M. S. BLACKETT.

The University,
Manchester.
Nov. 7.

[1] Euler and Heisenberg, *Ergeb. exak. Naturwiss.*, **17**, 1 (1938).
[2] See also Blackett, NATURE, **142**, 169 (1938).
[3] Auger, Ehrenfest, Freon and Fournier, *C.R.*, **204**, 257 (1937). See also *Rossi*, NATURE, in the Press.
[4] Johnson, *Phys. Rev.*, **43**, 307 (1933).
[5] Blackett, *Phys. Rev.*, in the Press.
[6] Compton and Turner, *Phys. Rev.*, **52**, 799 (1937).
[7] Humphreys, "Physics of the Air" (Philadelphia, 1930), Fig. 16 and Table 3.
[8] Blackett, *Proc. Roy. Soc.*, A, **159**, 1 (1937).

In a recent paper, Euler and Heisenberg[1] have thoroughly discussed the hypothesis that the hard component of the cosmic rays consists of 'mesotrons' produced in the upper layers of the atmosphere by primary electrons or photons and then disintegrating, as predicted by Yukawa's theory of nuclear forces, with a life-time τ of the order of 10^{-6} sec. (τ is relative to a system in which the particle is at rest; whilst in a system in which the particle is moving with a velocity $v = \beta c$ the life-time becomes[2] $\tau' = \tau/(\sqrt{1-\beta^2})$.)

In practice, the particles may disintegrate before they are brought to rest by ordinary loss of energy only in a gas, since in a liquid or solid absorber a 'mesotron' of a given velocity βc is stopped within a time which is very small in comparison with $\tau/(\sqrt{1-\beta^2})$. By traversing a gas absorber, the intensity of the hard component would therefore be more reduced than by traversing a liquid or a solid absorber of the same stopping power.

It has been pointed out that this theoretical result is confirmed by Ehmert's experiments, which give a difference of the kind expected between the absorption curves of cosmic rays in air and water[3].

In connexion with this, it is perhaps worth while to direct attention to some similar results previously obtained by De Benedetti and myself in Eritrea (geom. lat. 11° 30′ N., 2,370 m. above sea-level)[4]. In these experiments the absorption of the cosmic particles was measured: (*a*) in lead, by interposing lead screens between two counters placed one above the other; (*b*) in air, by inclining the counter system, thus increasing the thickness of the air layer traversed by the particles. In a first experiment, each counter was surrounded by a cylindrical lead shield of 1·7 cm. thickness. Full absorption curves were taken; the lead curve begins with a steep decline (owing to the absorption of the soft component, which is not completely cut off by the lead cylinders) but it then becomes nearly horizontal. The air curve, on the contrary, descends smoothly, cutting the lead curve at about 120 gm./cm.^{2}.

In a further experiment, 4 cm. of lead was placed permanently between the counters (in addition to the lead cylinders) in order to avoid the disturbing effect of the soft component. One point only of each absorption curve was measured, namely, at 136 gm./cm.^{2} (12 cm.) lead and at 121 gm./cm.^{2} air (counter system inclined by 30°). The results were as follows:

	coinc./min.
Counter system vertical, lead cylinders + 4 cm. lead:	0·626 ± 0·009
" " " " " + 4 + 12 cm. lead:	0·575 ± 0·009
" " inclined, " " + 4 cm. lead:	0·516 ± 0·008

Both experiments show very definitely that the hard component is much more reduced by air than by lead. The difference would have been still greater in absence of the earth's magnetic field, which acts in the sense of diminishing the observed air absorption, as the counter system was inclined in a *westerly* direction. We may correct for the magnetic influence approximately by taking the average of the intensities in the western and in the eastern direction, which differ, under the actual experimental conditions, by a factor of about 1·2. We shall use, therefore, instead of the measured value 0·516, the corrected value $\frac{1\cdot1}{1\cdot2} \times 0\cdot516 = 0\cdot473$ for the frequency of the coincidences at 30°.

The difference between the air and the lead absorption, for which no satisfactory explanation had been found at that time, can now easily be accounted for on the disintegration hypothesis. The inclined rays have, of course, to travel a greater distance than the vertical ones before they reach the counters.

We assume that all the observed 'mesotrons' are produced at a given depth R below the top of the atmosphere, where R, as pointed out by Blackett[5], has to be measured in the actual direction of the incoming particles. The difference Δl between the paths of the particles, which, at an altitude of h km. above sea-level, are observed at a zenithal angle φ and in the vertical direction respectively, is then given by the formula:

$$10^{-5}\,\Delta l = \left(\frac{10\cdot33}{1\cdot29}\log\frac{1033}{R} - h\right)\left(\frac{1}{\cos\varphi} - 1\right) - \frac{10\cdot33}{1\cdot29}\,\frac{\log\cos\varphi}{\cos\varphi}.$$

Putting $h = 2\cdot37$, $\varphi = 30°$ and taking for R the value corresponding to the maximum of the Regener-Pfotzer curve, namely, 100 gm./cm.^{2}, we get $\Delta l \sim 4 \times 10^5$ cm.

On the other hand, since the loss of energy by ionization is about the same in 121 gm./cm.^{2} of air and in 136 gm./cm.^{2} of lead, we may assume that the relative number $\Delta n/n$ of mesotrons which disintegrate by travelling the distance Δl is given by

$$\frac{\Delta n}{n} = \frac{0\cdot575 - 0\cdot473}{0\cdot626} = 0\cdot165.$$

This result enables us to calculate the life-time of the mesotrons. If we suppose, for reasons of simplicity, that they all have the same energy, say, ε times the rest energy μc^2, with $\varepsilon \sim 40$, we have:

$$\tau = \frac{\Delta l}{\beta c}\,\frac{n}{\Delta n}\sqrt{1-\beta^2} \sim \frac{\Delta l}{c}\,\frac{n}{\Delta n}\,\frac{1}{\varepsilon} \sim 2 \times 10^{-6}\ \text{sec.}$$

We obtain, therefore, a life-time just of the order of magnitude previously given. Chiefly owing to the uncertainty in the value to be introduced for ε, the above estimate may be too low or too high by a factor 2.

BRUNO ROSSI.
Universitetets Institut for teoretisk Fysik,
København.
Nov. 4.

[1] Euler, H., and Heisenberg, W., *Ergeb. exak. Naturwiss.*, **17**, 1 (1938). The same point of view has been developed in a discussion at the Physical Institute in Rome. I am indebted to Prof. Bernardini for telling me of this. See also Blackett, P. M. S., NATURE, **142**, 992 (1938).

[2] Bhabha, H. J., NATURE, **141**, 117 (1938).

[3] Ehmert, A., *Z. Phys.*, **106**, 751 (1937).

[4] Rossi, B., *Ricerca Scient.*, **51**, 579 (1934); *Phys. Rev.*, **45**, 212 (1934); De Benedetti, S., *Ricerca Scient.*, **51**, 590 (1934); *Phys. Rev.*, **45**, 214 (1934).

[5] Blackett, P. M. S., see letter above. I am indebted to Prof. Blackett for a discussion on this point at the conference on cosmic rays held in Copenhagen on Oct. 25–29.

Range of Nuclear Forces in Yukawa's Theory

FOUR years ago, Yukawa, in an attempt to develop a relativistic theory of the interaction of heavy particles in nuclei, was led to predict the existence of charged particles of mass intermediate between those of the electron and the proton[1].

In view of the great interest and hope raised by the striking discovery in cosmic rays of particles having just the desired mass, which one is naturally

tempted to identify with Yukawa's particles, it may be desirable to have a derivation as elementary as possible of the fundamental relation:

$$\rho = \frac{\hbar}{mc}, \qquad (1)$$

where ρ is range of the nuclear forces, $\hbar$ is Planck's constant, m is the mass of the 'heavy electron', c is the velocity of light, which led Yukawa to his remarkable prediction.

It may perhaps be of interest, therefore, to point out that the meaning of relation (1) may be simply illustrated by an argument based on Heisenberg's Uncertainty Principle, in close analogy to Bohr's discussion of Gamow's formula and other related problems.

The argument runs as follows: in Yukawa's theory the interaction between heavy particles is carried by the semi-heavy particles, by means of simple emission and absorption processes (much in the same way as the relativistic interaction between two electrons can be described in terms of emission and absorption of light quanta); these are not, of course, actual emission and absorption processes, which would be contrary to the energy principle; they are called, therefore, virtual transitions. Let us see, however, a little closer how it comes about that the energy principle is respected. One might try to show that this is not so by setting up some device which could 'see' the heavy electron whilst it is travelling from one heavy particle to the other. In this case the energy principle can only be saved, as usual, if the uncontrollable energy exchange involved in the operation of the device is so large as to cover the energy excess actually observed, which is at least mc^2. Now the time t employed by the Yukawa particle in travelling from one heavy particle to the other is at least r/c, where r is the distance between the heavy particles. The time of operation of the device must on the other hand be smaller than t (otherwise the system will react as a whole, and the device will not be able to detect the presence of the individual Yukawa particle), but it need not be essentially smaller than this. We see, therefore, that the energy uncertainty will be, at most:

$$\triangle E \sim \hbar c/r.$$

The condition:

$$\triangle E > mc^2$$

actually gives the distance (1) as the limit up to which virtual transitions can make themselves felt without contradiction of the energy principle. It may be remarked that by assuming a velocity of the intermediate particle smaller than c, it is only possible to reduce the energy uncertainty further, so that the consideration of relativistic velocities actually gives the optimum conditions or the upper limit to which the interaction may extend.

I am very glad to express my thanks to Prof. N. Bohr for his kind interest and the Fondazione Volta of the C.d.R. for a grant enabling me to stay in Copenhagen.

G. C. WICK.

Istituto Fisico,
Palermo.
Oct. 31.

[1] Yukawa, H., *Proc. Phys. Math. Soc. Japan*, **17**, 48 (1935); see also Fröhlich, H., Heitler, W., Kemmer, N., *Proc. Roy. Soc.*, A, **166**, 154 (1938), and several papers quoted there.

Vector Maps as Positive Evidence in Crystal Analysis

THE principle of crystal analysis by means of vector maps may be indicated briefly as follows. If the electron density throughout a crystal is expressed by a triple Fourier series ρ whose typical coefficient is the complex number a, the triple Fourier series V whose typical coefficient is the real number $|a|^2$ has two properties: (1) the coefficients in V are determinable from and collectively resume all the information given by observations of intensities of reflected X-rays; (2) a maximum value of V corresponds in position to a step between positions for which ρ is a maximum. Since the points at which maximum values of ρ occur are the individual atoms, we can say that the observed data are made to furnish directly the vector map of the atomic structure. The ultimate usefulness of the method depends, therefore, theoretically on the extent to which a vector map S_2 determines, or at least characterizes, the nuclear structure from which it is derived, practically on the efficiency of a mathematical technique for achieving such deduction as is theoretically within reach. Until recently, it was thought that the direct value of the vector map was small and that the map was in effect only a test to be applied to structures suggested independently, and by showing that the main features of the atomic structure can be read from the map and that in many cases every detail of the atomic structure is implicit in the details of the map, Dr. Wrinch has opened a new chapter in crystal analysis[1].

An argument has been used which purports to demonstrate without the trouble of examining specific instances that substantial reconstruction is theoretically impossible. Since the vector series V is unaffected by a change in the angle of any coefficient a provided that the modulus $|a|$ is unchanged, one series V is common to a multiply continuous infinity of density series ρ. Therefore, runs the argument, every vector series must be common to an infinity of atomic structures, and we must accept the depressing conclusion that although an immense amount of toil has been devoted to collecting intensity observations and constructing vector diagrams for actual substances, this toil and the ingenuity and patience which have been needed for the discovery of structures compatible with the diagrams have alike been wasted, since the probability that a particular structure found in this way is the correct one remains in any event negligibly small.

When, however, we set to work actually to infer an atomic structure S_1 from a given vector map S_2, nothing is clearer than that the possibilities are finite and the probabilities far from zero. A trivial example is in this respect typical: the map which consists of the origin O, a single point A, and the image of A in O, is the map of a point-pair congruent with OA, and cannot conceivably be the map of any other configuration. Dr. Wrinch is undoubtedly right: the Patterson diagrams contain far more information than was suspected before she began to study the published insulin diagrams for herself. In fact, reconstruction of a discrete point-set from its vector map is a systematic process. At various stages alternatives must be examined, but the analysis is exhaustive. Sometimes it happens that a problem has two or more solutions, but geometrically this would seem to be a rare accident. There are no parameters in the solutions. The notion that the atomic structure remains hopelessly indeterminate however thoroughly the vector analysis is carried out is quite

untenable; it is obviously absurd in the simplest cases, and gains nothing in plausibility when the map is complicated, for the number of conditions to be satisfied by the interatomic measurements rapidly outstrips the number of measurements available.

The explanation of the discrepancy is not hard to find. An arbitrary density series ρ does not represent even approximately the state of high concentration near isolated nuclei that we translate as an atomic structure. Stringent conditions must be satisfied if ρ is to correspond to a point-set. If then the coefficients in ρ vary while the derived vector series V is unchanged, this does not imply continuous variation of an atomic structure: it is only that the sharpness with which ρ represents such a structure is lost, usually beyond discovery.

Experiment cannot furnish all the coefficients of an infinite series. In utilizing the observational data we have to be content with a vector series which is reduced to a small number of leading terms, and with a density series which accounts for these leading terms. On any view we must regard a curtailed density series as nothing more than a useful approximation, and a point structure that would imply a discrete vector map is nothing less than another approximation which has an equal claim to consideration. But we must not think of the two approximations as exclusive alternatives. We can change from one form of approximation to the other halfway through a single investigation, and when we have been shown that discrete maps are decipherable we realize that this is just what we must do. Intensity measurements provide a V series; the V series provides a family of surfaces the nuclei of which constitute a set which from its physical origin must, within the observational limits of accuracy, be the vector map S_2 of some point structure S_1. The problem is now one for the mathematician, whose verdict on the evidence is final. If there is only one S_1 from which the S_2 is derivable, that S_1 is as perfect a picture of the atomic structure as the observations justify. Should there be more than one S_1, the problem remains open until reasons for discrimination are found, but such reasons must lie elsewhere than in the X-ray measurements. It should be added that while multiplicity of solutions is possible, the more elaborate the vector map the less is the likelihood of multiplicity. In other words, as the labour of proving the uniqueness of a solution becomes prohibitive, the probability that a structure which has the right map is the correct structure increases, and in the case of a megamolecule, if one atomic structure is shown to fit the facts exhibited in the vector diagrams, criticism which does not begin by providing another structure which also fits these facts need not be taken too seriously.

E. H. NEVILLE.

University, Reading.
Nov. 15.

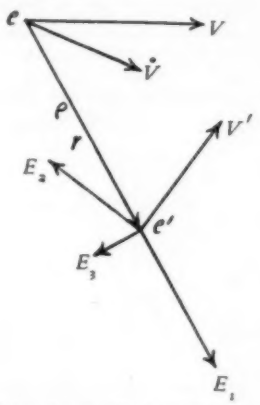
[1] See, for example, NATURE, **142**, 955 (1938).

A Comprehensive Fundamental Electrical Formula

IN a letter on "Fundamental Physical Concepts" which appeared in NATURE of August 13, I suggested that it should be possible to dispense with magnetic considerations in fundamental physical theory, and to express the forces acting on elementary electric charges at rest and in uniform or accelerated motion by a single comprehensive formula; and I was very glad to learn from Mr. Rollo Appleyard's letter in NATURE of September 17 that Sir Horace Lamb had expressed the desirability of dispensing with the duality of electricity and magnetism. Such a formula has now been worked out and may be expressed most conveniently in the form:

$$f = m'\dot{V}' = Ee' = \frac{ee'}{r^2}\left\{\rho + ([V'[V\rho]] + [\rho[\rho\dot{V}]])/c^2\right\},$$

where f is the force on a charge e' moving with vector velocity V', due to a charge e moving with vector velocity V and acceleration $\dot{V}$; ρ is the vector distance ee' of length r; and c is the velocity of electric wave propagation in space. The charges e and e' and the electric force E are in c.g.s. electrostatic units; m' is the total mass of e', including its 'electromagnetic mass'; and the square brackets imply vector products.



The electric force E has three components: $E_1 = \frac{e}{r^2}\frac{\rho}{r}$, which is obviously the electrostatic force in the direction of ρ; $E_2 = \frac{e}{c^2r^2}[V'[V\rho]]$ perpendicular to V' and in the plane $V\rho$, which represents the force on a current element $i'ds' = e'V'/c$ due to a current element $ids = eV/c$ and is derivable from Ampère's experiments; and $E_3 = \frac{e}{c^2r^2}[\rho[\rho\dot{V}]]$ perpendicular to ρ and in the plane $\dot{V}\rho$, which is due to the electric wave excited by the acceleration of e. This last term covers current induction and leads directly to Neumann's inductance formula $M = \iint ds\, ds' \cos\varepsilon/r$, but it has the advantage of giving the electric force E itself instead of its line integral round a closed circuit, and hence of being applicable to unclosed conductors. The accompanying diagram shows the three electric forces E_1, E_2 and E_3, when V, V', $\dot{V}$ and ρ are coplanar.

It will be noticed that no magnetic quantities whatever appear in the formula, as the permeability of space is implicitly included in the velocity $c = 1/\sqrt{\varkappa_0\mu_0}$, which is determinable by purely electrical measurements. If the charges e and e' are in a medium of relative permittivity $\varkappa$ and permeability μ, the formula becomes

$$f = Ee' = \frac{ee'}{\varkappa r^2}\left\{\rho + ([V'[V\rho]] + [\rho[\rho\dot{V}]])/v^2\right\},$$

where $v^2 = c^2/\varkappa\mu$, which introduces the permeability μ explicitly, as Mr. Appleyard suggested, but it need not be considered as a magnetic quantity as it is

determinable by search coil methods which do not involve magnetic measurements. It must be borne in mind, however, that all material media are aggregations of ions, each of which exercises its individual influence, so that this latter formula is only a convenient one for practical applications.

C. V. DRYSDALE.

The Athenæum,
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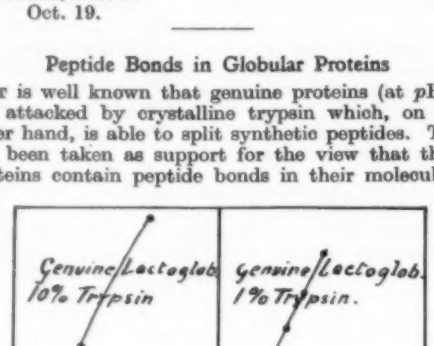
Oct. 19.

Peptide Bonds in Globular Proteins

IT is well known that genuine proteins (at *p*H 7) are attacked by crystalline trypsin which, on the other hand, is able to split synthetic peptides. This has been taken as support for the view that these proteins contain peptide bonds in their molecules[1].



We wish, however, to point out that in the light of the following consideration, this support loses a great deal, if not all, its importance. If, according to Anson and Mirsky, denaturation is reversible, then in a solution of a given globular protein there is an equilibrium between genuine and denatured protein,

$$G \rightleftharpoons D.$$

Hence it is sufficient that D and only D should contain peptide bonds open to fission by trypsin, because by removal of D by hydrolysis this process is forced in the direction from left to right and G will gradually disappear as well. The problem is open to experimental test in two different ways.

(1) When the protein is hydrolysed with so much trypsin that the rate of the above process becomes the limiting factor in the total reaction, then we must expect the temperature coefficient for the hydrolysis to approach that of the reversible denaturation, which is presumably very high.

(2) If a protein solution is heated for a short time to a temperature at which the process is proceeding rapidly and completely from left to right and then quickly cooled down to a temperature where it is a slow process, a protein solution is obtained which contains initially more D than corresponds to the equilibrium at that (low) temperature. Hence we may expect to find a more normal (that is, a lower) temperature coefficient for the hydrolysis of the protein in this solution. Upon standing, the equilibrium will slowly be reached and the temperature coefficient of the hydrolysis by much trypsin will tend to rise correspondingly.

Some preliminary results are shown in the accompanying figure.

(1) Equal volumes of 2 per cent lactoglobulin and 10 per cent trypsin (Merck) were mixed. The reaction was followed by precipitation with trichloroacetic acid and the ordinates are the values for the nitrogen soluble in this acid. The reaction temperatures chosen were 30° and 40°; *p*H was 7.

(2) As (1), but with 1 per cent trypsin.

(3) As (1), but the lactoglobulin solution was heated for 1 minute to 100° and rapidly cooled down again. Trypsin was added immediately.

(4) As (3), but the trypsin was added 20 hours later.

(Commercial trypsin was used because it contained very little substance precipitable by trichloroacetic acid under the conditions applied. In addition, it contained large quantities of enzymes which break down further the split products from the trypsin hydrolysis. This is rather an advantage, since it is possible that these split products give precipitates with trichloroacetic acid.)

(1) and (2) show that there is a small but distinct rise in the temperature coefficient of the initial hydrolysis rate, K, with increasing trypsin concentration (1 per cent trypsin $K_{40}/K_{30} = 3{\cdot}3$, 10 per cent trypsin $K_{40}/K_{30} = 4{\cdot}3$).

(1) and (3) show a pronounced fall in the temperature coefficient after the protein solution has been heated ($K_{40}/K_{30} = 1{\cdot}9$) and cooled again.

(3) and (4) show that this effect is partly reversible.

These experiments provide sufficient basis for giving a warning against the conclusion that genuine proteins contain peptide bonds because they are split by proteinases like trypsin. They give a certain indication that peptide bonds are formed or 'appear' (like SH-groups) upon denaturation, but they are not conclusive enough to decide whether or not some hydrolysable peptide bonds are pre-formed in the molecules of the genuine globular proteins.

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[1] Linderstrøm-Lang, K., *Collegium*, **10**, 561 (1937).

New Derivatives of the Silyl Radical

THE compound monochlorosilane, SiH_3Cl, prepared in 1919 by Stock, was shown by him to yield volatile monomeric derivatives in its reactions with water and ammonia. With water it forms the compound $(SiH_3)_2O$, which is a gas, b.p. $-15{\cdot}2°$; and with ammonia the product is an amine-like body of the formula $N(SiH_3)_3$, b.p. $+52°$. This field appeared to us to be one which was capable of great extension, and we have already made a number of interesting

observations. Thus we find that monochlorosilane reacts spontaneously and quantitatively with methylamine according to the equation:

$$3CH_3NH_2 + 2SiH_3Cl = CH_3.N(SiH_3)_2 + 2CH_3NH_3Cl.$$

The product, methyldisilylamine, is a liquid, b.p. + 32·3°, which is stable in air, but is quantitatively hydrolysed by alkali: its formula has been established by analysis and by vapour density determinations. It differs from aliphatic amines in being quantitatively decomposed by hydrogen chloride:

$$CH_3N(SiH_3)_2 + 3HCl = 2SiH_3Cl + CH_3NH_3HCl.$$

Ethyldisilylamine, prepared by identical methods, is a liquid of very similar properties, boiling at + 65·9°.

Trimethylamine and monochlorosilane have been found to combine in the cold in strictly equal volumes, giving a stable solid quaternary compound $N(CH_3)_3SiH_3Cl$. This differs from the organic quaternary compounds in being instantaneously decomposed by water to form trimethylamine hydrochloride and disiloxane, $(SiH_3)_2O$. It is also decomposed on standing in moist air. The ultimate products in this case are silicic acid and trimethylamine hydrochloride; but the intermediate products are soluble in water, giving solutions with strong reducing properties. It is hydrolysed by alkali according to the equation:

$$N(CH_3)_3SiH_3Cl + 3NaOH = Na_2SiO_3 + NaCl + N(CH_3)_3 + 3H_2.$$

The dissociation pressure of the salt is 9 mm. at 20°, and this increases to one atmosphere at 91°. The dissociation, however, is not reversible, due to the disproportionation of the SiH_3Cl formed, thus:

$$N(CH_3)_3SiH_3Cl \rightleftharpoons N(CH_3)_3 + SiH_3Cl$$
$$2SiH_3Cl \rightleftharpoons SiH_4 + SiH_2Cl_2$$

Trimethylsilylammonium chloride is a convenient silylating agent, as the trimethylamine present will fix quantitatively any hydrogen chloride formed in a reaction. Thus we have shown that it will react with alcohols to form volatile silyl alkyl ethers, which may be isolated with ease; for example:

$$C_2H_5OH + N(SiH_3)(CH_3)_2Cl = SiH_3.O.C_2H_5 + N(CH_3)_2HCl.$$

Monochlorosilane and dimethylamine react at room temperature with the production of the compound $N(SiH_3)(CH_3)_2$. This amine appears to form an unstable quaternary salt with excess of monochlorosilane. There is thus a gradual decrease in the stability of these quaternary salts, and we may formulate the following series:

I.	$N(CH_3)_4Cl$	Stable.
II.	$N(SiH_3)(CH_3)_3Cl$	Moderately stable.
III.	$N(SiH_3)_2(CH_3)_2Cl$	Unstable.
IV.	$N(SiH_3)_3(CH_3)Cl$	Not formed.
V.	$N(SiH_3)_4Cl$	Not formed.

The members IV and V, had they been formed, would have been detected in the preparation of the amines $N(SiH_3)_2(CH_3)$ and $N(SiH_3)_3$, since both of these preparations were carried out in the presence of an excess of monochlorosilane.

We are at present extending these observations, and attempting to prepare compounds of the silyl radical with other elements, such as phosphorus, arsenic and lead.

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A Degradation Reaction in Organic Chemistry

THE method described below by means of examples enables the group -CO-CO-CO- or -CO-CH_2-CO- to be converted into the dicarbonyl group -CO-CO-, which is virtually the degradation of a propane derivative into an ethane derivative.

For example, diphenyltriketone (I) is changed by warming with acids (for example, sulphuric acid-acetic acid) into benzil (II):

$$\underset{(I)}{Ph.CO.CO.C.OPh} \xrightarrow{acids} \underset{(II)}{Ph.CO.CO.Ph}$$

The conversion of dibenzoylmethane (III) into benzil involves first the change of the group -CO.CH_2.CO- into -CO-C-CO- (IV) and then warming

$$\text{-CO-C(=N)-CO-}$$

the resulting product with acids (for example, sulphuric acid-acetic acid). The nitrogen-containing intermediate compound with the group (IV) may be (V), which is readily obtained in half an hour by the action of (III) on nitrosobenzene in alcohol. Diphenyltriketone-2-anil oxide (V)[1] forms yellow crystals, m.p. 144°.

$$\underset{(III)}{Ph.CO.CH_2.CO.Ph} + 2\,Ph.NO \rightarrow$$

$$\underset{(V)}{Ph.CO.C(=N(O)).CO.Ph} + Ph.NHOH$$

$$(V) \xrightarrow{acids} (II)$$

Robert Michaelis and Cezar Azzam participated in this investigation.

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[1] Compare Schönberg, A., and Michaelis, R., *J. Chem. Soc.*, 627 (1937).

Kinetics of Exchange Reactions

THE shape of the curve obtained by plotting the concentration of a reactant or product against the time can in general be used to yield information about the way the rate of the reaction depends on concentration, in particular about its order. In the case of isotopic exchange reactions this is not possible even in principle, supposing the isotopes to have identical chemical properties. This rather amusing result does not appear to have been placed on record hitherto.

Suppose the reaction is

$$AX^* + BX = AX + BX^*,$$

where X^* represents a labelled (for example, radioactive) X atom. Let the concentrations be: AX, a; BX, b; AX^*, x; and BX^*, y; if the compounds contain several similarly situated X atoms, these concentrations must be expressed in equivalents of X. We will assume that $a \gg x$ and $b \gg y$. Let the exchange proceed at a rate

$$R = k.f(a).\varphi(b),$$

where f and φ are *any* functions, and k is a constant. Then

$$\frac{dx}{dt} = -\frac{dy}{dt} = -\frac{x}{a}R + \frac{y}{b}R,$$

where t is the time. If $x = 0$ when $t = 0$, and $x = x\infty$

when $t = \infty$, these equations can be integrated to give

$$-\ln\left(1-\frac{x}{x_\infty}\right) = R\left(\frac{a+b}{ab}\right)t.$$

Thus the shape of the x, t – curve is given *exactly* by simple theory, and is independent of the form of R; whether the reaction is uni-, bi-, or termolecular, or something more complicated, the x, t – curve is that for a reversible unimolecular reaction.

The reason for this particularly simple result is, of course, that the composition of the reacting mixture remains chemically unchanged throughout the reaction, so that we get $k.\frac{x}{a}.f(a)\varphi(b)$ instead of $k.f\left(\frac{x}{a}\right)\varphi(b)$ for the rate of the forward reaction, and a similar expression for the rate of the backward reaction. By changing a and b we can, of course, determine $f(a)$ and $\varphi(b)$, that is, determine the order of the reaction.

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Manifold Effects of Male and Female Sex Hormones in both Sexes

IN our previous experiments[1] the hormones were usually injected into gonadectomized rats for a period of 21–23 days. This comparatively short treatment produced definite effects on the non-sexual organs (except spleen) of males, but the effects were less evident or absent in most of these organs in females.

In the present experiments, 91 castrated and 88 ovariectomized rats have been injected for a period of 2½ to 4 months with the following hormones and doses (per week): androsterone 7·5 mgm.; transdehydroandrosterone 7·5 mgm.; testosterone propionate 0·75–7·5 mgm.; and (in males only) testosterone 0·75–7·5 mgm., alone or simultaneously with œstradiol dipropionate, 0·018–0·200 mgm., our usual experimental technique being used[1].

The effects obtained on the organs investigated were very similar in males and females, varying as a rule only in degree. The accompanying table containing, for the sake of economy of space, the average weights of some organs only, gives examples of the changes observed in females.

Hormone injected		Actual weights of organs			
Male hormone (mgm. per week)	Œstradiol dipropionate (mgm.) per wk.	Hypophysis (mgm.)	Liver (gm.)	Heart (mgm.)	Gain in body wt. (gm.)
None (control rats) ..	none	11·9	8·31	737	165
None	0·090	98·0	7·61	623	73
None	0·200	132·2	6·77	596	13
Androsterone, 7·5 ..	none	10·8	11·39	928	199
Androsterone, 7·5 ..	0·090	48·0	8·96	723	112
Testosterone prop., 2·25	none	10·9	10·42	935	139
Testosterone prop., 2·25	0·200	60·2	7·91	621	64

Some important conclusions are obvious from the data given in this table and from the other results (not given here) obtained with females and males.

(1) While œstrogens produce *stunted growth* and decreased *fat deposition*, with the male hormones this depressing effect is absent or (with large doses of testosterone propionate) slight.

(2) Moreover, this depressing effect of œstrogens is to some extent neutralized by the simultaneous injections of male hormones (except dehydroandrosterone), thus indicating some antagonistic relation between œstrogens and male hormones (see table).

(3) Both male and female hormones accelerate the physiological involution of the *thymus*, having a co-operative effect on this organ, when injected simultaneously.

(4) The male hormones have a definite effect on *adrenals* in males, causing the hypertrophied 'castration' glands to return to or towards normal. The histological changes which occur have been discussed elsewhere (Hall and Korenchevsky[2]). Simultaneous injections with œstrogens in most cases prevent this restorative effect on size and weight of adrenals. In females, similar results have been obtained with androsterone, but the effects of the other hormones and of ovariectomy were indefinite.

(5) While male hormones do not produce any considerable change in weight of the *hypophysis*, certain doses of œstrogens cause a tumour-like hyperplasia of the gland (see table). When injected simultaneously, male hormones neutralize to a considerable extent (in one male rat almost to normal—14 mgm.) this hyperplastic effect of œstrogens both in males and (see table) in females. This is another important case of antagonistic relations between male and female hormones.

(6) Slight hypertrophy of *liver*, *kidneys*, *heart* and *spleen* in gonadectomized animals is produced by male hormones, while œstrogens cause either a decrease in their actual weight or no change (kidneys). This effect of œstrogens is in some organs partly dependent on the body weight, which relation, suggesting a possible stimulating effect on the kidneys, will be discussed elsewhere. When injected simultaneously the effect of male hormones on the actual weights of these organs is antagonistic to, and to some extent neutralizes, that of œstrogens in both sexes (see table).

The data presented (1) confirm a definition, previously given[3], of gonadal hormones as not merely sex hormones, but as hormones also possessing manifold important effects on non-sexual organs; (2) show the co-operative and antagonistic interrelations between male and female hormones, supplementing similar results previously obtained[1] on sexual organs.

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[1] See references: Korenchevsky, V., *Brit. Med. J.*, ii, 896 (1937).
[2] Hall, K., and Korenchevsky, V., *J. Physiol.*, **91**, 365 (1938).
[3] Korenchevsky, V., and Dennison, *M.*, *J. Path. and Bact.*, **38**, 231 (1934).

Antarctica and Glacial Ages

IN NATURE of September 17 there is an interesting discussion between Rev. W. S. Fleming and Prof. E. W. MacBride in regard to the Gondwana flora and glaciation in Antarctica in Permo-carboniferous times which requires some comment. Referring to the Permo-carboniferous ice age, Prof. MacBride suggests that a vast Gondwana continent in temperate parts of the southern hemisphere drifted south across the south pole, Australia and Antarctica, which lay at its north edge, being left behind in temperate

latitudes. The rest of the continent underwent severe glaciation and finally broke up into South America, South Africa and the Deccan of India.

Why Australia, which was heavily glaciated, was left behind is difficu t to understand, unless it was because the Australian geologists interpret their tillites as due to the work of floating ice. If Australia, in temperate latitudes, was severely glaciated, why was it necessary for the other glaciated regions to be bundled together and drifted across the pole ?

In reality, all the heavily glaciated regions were close to the sea and a compact Gondwanaland certainly did not exist while glaciation was going on. The Indian tillites are associated with marine beds at two points hundreds of miles apart. The South American tillites are found with marine deposits both in Brazil and on the western side ; and in South Africa on its south-western side its ice sheet reached the sea. (See "Ice Ages, Recent and Ancient", pp. 102-3, 134, 146-9, 168.) This, of course, is what one should expect, since the building of an ice sheet demands an immense amount of evaporation from some nearby body of warm water. In the Pleistocene, north-western Europe and north-eastern America near the Atlantic with its Gulf Stream were heavily glaciated, while Siberia, one of the coldest parts of the earth, had no important ice sheet. A huge land mass, such as the supposed Gondwanaland, even at the south pole, would lack precipitation in its central parts, and so would be unglaciated.

Late Palæozoic glaciation in Australia deserves some further mention. The geologists of the Commonwealth have proved that there were two important glaciations, one in the Carboniferous, the other much later, separated by a very long interglacial time when great coal seams were laid down. Are we to suppose that Australia was pushed towards the south pole in the Carboniferous and then pulled up to a temperate latitude for coal plants to grow, and then pushed down again for the second glaciation?

Also what about the Permo-carboniferous tillites at Squantum near Boston and on the Alaskan boundary in North America, and the glacial deposits described in France and Germany ? Surely Gondwanaland had nothing to do with these deposits in the northern hemisphere.

In a great ice age, like the Pleistocene and the Permo-carboniferous, the whole world is chilled, though great ice sheets are formed only in regions favourably placed for moisture-laden winds to deposit snow.

May an old-fashioned geologist ask the advocates of drifting continents how they account for the extraordinary performances they so readily assume ? On the Labrador coast one may see icebergs pushing southward, thrusting aside the ice-floes, or sometimes ridging them up in front, but one knows that the greater part of the berg is sunk in the arctic current, so that the motion is accounted for.

Our iceberg-like continents are solidly frozen into the sea bottom crust, supposedly miles in thickness of strong basalt. Are there currents in the supposedly plastic basic substratum in which the bulbs of the continents are enclosed ? Or what forces push them in one direction rather than another ? To say they 'drift' is, of course, begging the whole question. Permanently enclosed rock-masses cannot drift—they must be pulled or pushed. What power do the advocates of the 'drift of continents' suppose dragged India from the antarctic regions thousands of miles north, over the bulge of the equator, to leave it in the northern hemisphere ? Where are the heaped-up ridges of rock which it thrust up on each side, and where is the scar it left after its passage ? Again, why did Gondwanaland explode and send South America in one direction and South Africa in another and leave Antarctica where it is ?

These casual driftings of massive blocks of the earth's solid crust should have some reasonable explanation before being used to account for the distribution of plants or animals. The Gondwana plants are mainly ferns, equisetums and club-mosses, especially ferns—all cryptogams the spores of which could easily be transported by the wind. A gale would quickly carry them hundreds of miles. Why send continents crashing through the solid earth's crust to effect their distribution ?

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Formation of Widmanstätten Figures in Meteorites

INVESTIGATIONS have been conducted in this laboratory during the last few years on the structure of artificially prepared iron-nickel alloys in the iron end of the equilibrium diagram, and during the last year the structure of iron-nickel meteorites has also been examined. An interesting point in connexion with meteorites is the formation of etched patterns known as Widmanstätten figures. Several attempts have been made to explain these figures, but no satisfactory theory seems, so far, to have been advanced.

I wish to mention here certain conclusions reached in the course of the investigations referred to, which may be helpful in arriving at a satisfactory explanation of the existence of these figures.

(1) An iron-nickel alloy containing, say, between 6 and 25 per cent of nickel, when quenched from high temperature, consists solely of a distorted body-centred lattice which is in metastable equilibrium at ordinary temperatures. It is suggested that this is the condition of meteoric iron-nickel after the sudden drop in temperature which occurs when the meteorite comes to rest in the earth, and that afterwards prolonged annealing at a comparatively low temperature has taken place.

(2) The alloy possessing, as it does, a distorted lattice, is supersaturated with nickel. The result of this is that internal stresses exist in the material. This condition is favourable to the growth of single crystals when the material is annealed, and this growth may take place at moderately low temperatures.

(3) The growth of the crystals occurs in sheets parallel to the octahedral planes of the distorted lattice, the growth being much more rapid in the direction of the octahedral plane than at right angles to it. These crystals are the stable kamacite or undistorted α-lattice, the composition of which corresponds with that at the pure α-phase boundary at the temperature of annealing.

(4) During the process of crystal growth, the surplus nickel in the lattice is gradually displaced and collects on the surfaces of the kamacite sheets. When the concentration of nickel reaches a certain value, tænite is formed. Thus tænite appears in the form of very thin sheets bordering crystals of kamacite. It may be expected also, that as the result of this process, a definite relation exists between the orientation of kamacite and tænite crystals. Different observers have found this to be the case.

(5) The lower the nickel content of the alloy as a whole, the greater is the width of the kamacite plate, because more volume of kamacite will have to be formed in order to expel a sufficient number of nickel atoms to produce tænite at the boundary. This explains the different degrees of 'coarseness' found in meteorites (octahedrites).

(6) Meteorites within a certain range of composition generally contain plessite, which may consist of a microscopic octahedral arrangement of kamacite and tænite, or may be of a granular structure similar to that of the metastable distorted α alloy. When the plessite is in the latter form the meteorite has not reached its final state of equilibrium, a conclusion which may appear strange when, to quote one writer, meteorites "have presumably had geological ages in which to reach equilibrium". But according to the views expressed here, any equilibrium which might have been established would be upset by the final heating of the meteorite in passing through the atmosphere and in penetrating the earth's crust, followed by sudden cooling.

(7) If plessite may be regarded as consisting only of the metastable distorted α lattice, it should not exist in an alloy which has reached its final and true state of equilibrium, this state consisting only of stable kamacite and tænite.

The above general statements will be amplified and supplemented by experimental data in a series of papers which will shortly be published.

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A Visual Phenomenon

ON starting an electric fan with the observer so placed that he can see the sky (or other bright background) through the vanes of the fan, then at a certain speed of rotation a hazy violet patch of colour can be seen in the plane of the fan. At higher rates of rotation the effect disappears, but can again be observed on decreasing the speed to the critical value. The speed in question appears to correspond with the frequency of flicker. The effect was actually observed in the case of a fume cupboard extractor fan.

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Points from Foregoing Letters

PROF. P. M. S. BLACKETT calculates the mean range of the mesotrons (particles of mass intermediate between that of the electron and that of the proton) from the relative intensity of the inclined cosmic rays to the vertical rays, and also from the absorption anomaly between air and water. He arrives at a value of $1{\cdot}7 \times 10^{-6}$ sec. for the decay time of a fast-moving mesotron, assuming its mass to be 150 times that of the electron. Prof. B. Rossi obtains a value of the same order of magnitude for the life of the mesotron from calculations based upon the anomaly of absorption of cosmic rays by air and by lead, when vertical and inclined counters were used.

A simple demonstration of Yukawa's relation $\rho = h/mc$, from which the existence of particles of intermediate mass (mesotrons) was inferred, is given by Prof. G. C. Wick, based upon Heisenberg's Uncertainty Principle.

When inferring crystal stucture from X-ray vector maps possibilities are finite, according to Prof. E. H. Neville. It is rare that two or more solutions are possible, especially in the case of a megamolecule. If one structure is shown to fit the facts exhibited in the vector diagrams, any serious criticism must begin by providing an alternative structure that fits the diagram.

A fundamental electrical formula which expresses the forces acting on elementary electric charges at rest and in uniform or accelerated motion, without introducing magnetic quantities (thus dispensing with the duality of electricity and magnetism), has been worked out by Dr. C. V. Drysdale.

The fact that genuine proteins are split by proteinases (such as trypsin) does not prove that they contain peptide bonds, according to Dr. K. Linderstrøm-Lang, R. D. Hotchkiss and G. Johansen. A small but distinct rise in the temperature coefficient of the initial hydrolysis rate with increasing trypsin concentration and a pronounced fall in the coefficient when the protein has been first heated to 100° C. and then cooled, indicate that peptide bonds appear upon denaturation, but may not have existed in the original protein.

The preparation of certain monomeric compounds of silicon of a new type, containing both silyl and alkyl radicals, is announced by Dr. H. J. Emeléus and N. Miller. A quaternary salt, trimethylsilyl-ammonium chloride, containing such radicals, is also described; and its behaviour is compared with that of its analogues.

Prof. A. Schönberg describes a method by means of which the group -CO-CO-CO- or -CO-CH_2-CO- may be converted into the dicarbonyl group -CO-CO-, which is virtually the degradation of a propane derivative into an ethane derivative.

H. A. C. McKay points out that in the case of isotopic exchange reactions, where the isotopes have identical chemical properties, it would not be possible, even in principle, to determine the order of the reaction from a single concentration-time curve.

The effect of male and female sex hormones upon various organs (liver, heart, adrenals) of castrated or ovariectomized rats, is described by Dr. V. Korenchevsky and K. Hall. They show that the hormones produce manifold important results upon the non-sexual organs and that the male and female hormones have sometimes co-operative, and in other circumstances antagonistic, effects.

Prof. A. P. Coleman doubts Prof. MacBride's hypothesis of a Gondwana continent having drifted across the South Pole in Permo-Carboniferous times, and supplies alternative explanations for the glaciation effects observed in some of the Permo-Carboniferous rocks of the southern hemisphere.

Research Items

Canoes of the Pacific

IN the third and final volume of their study of the canoes of Oceania (Bernice P. Bishop Museum, Honolulu, *Special Publication* 29), Dr. A. C. Haddon and Mr. James B. Hornell deal with definitions of terms, a general survey and conclusions. It appears likely that the Papuans originally were acquainted only with the raft or simple dugout, possibly with a makeshift sail of palm leaves. The first wave of Indonesian migration into Melanesia may have brought the canoe with double outrigger with parallel, or stick connexions. It was possibly square-sail rigged, with mast yard, or boom. Later immigrants came with large double sailing canoes and sailing canoes with small outrigger with stick connexions for the booms. Probably they were rigged with some form of the Oceanic sprit-sail. These are the proto-Samoans of Churchill, the most ancient stratum of central and western Polynesia—the first Kava people. The later Kava peoples also had large sailing double canoes and large single outrigger canoes with stick and stanchion connexions. Their dugouts doubtless had strakes, which led to the plank-built boat. The true plank-built boat was employed only sporadically in western Oceania and is not a local development. It belongs to one of the later spreads from the West into Polynesia. The later Kava peoples, or some of them, the so-called Tangaroans, were instrumental in raising Polynesian culture to its highest level. The Tangaroans were also great navigators, and it may be under them that New Zealand was colonized by "the Fleet" in A.D. 1350. The migration of the betel-people into Melanesia was probably the last of these great movements, and to them the introduction of the various types of plank canoe, without outrigger, was due. The abandonment of the outrigger by the Maori was probably a local development. The colonizers of Hawaii, who brought a double canoe and a single outrigger, probably came direct through Micronesia about A.D. 400–450.

The Dionne Quintuplets

THE unique Dionne quintuplets are being studied genetically. Dr. John W. MacArthur presents the evidence (*J. Heredity*, 29, No. 9) that they represent a monozygotic set. The methods in use for twins have been applied to them. Employing the diagnostic criteria for distinguishing between identical and fraternal twins, each method, as well as the new quantitative method from dermatoglyphics, leads to the conclusion that they are monozygotic. There was evidently a single placenta and chorion, and probably five separate amnia and five cords attached in a ring. There may have been a sixth embryo which aborted very early. The children themselves and their nurses can recognize each of the five, but their facial features are very similar. The other sibs vary widely in hair colour, hair shape, eye colour, features, ears, etc. The finger-prints of the quintuplets are as like as in most identical twins, the palm and sole prints repeating some rare features; all ten feet have a mild syndactyly of the second and third toes and a peculiar thenar pattern complex. They are of the same blood group and very similar in eyes, hair and ears. When compared in pairs, no one stands apart from the rest, nor is any pair exceptional. It appears that forty-five cases of quintuplet births have been recorded in the literature, and at least two or three sets were monozygotic, but in this case alone have all survived.

Kinetics of Choline Esterase

THE kinetics of the enzyme which splits acetylcholine in the body, choline esterase, have up to the present only been studied on relatively high concentrations of acetylcholine. In the organism, acetylcholine is active in very minute amounts, and for this reason, some knowledge of the effects of esterase on low concentrations was desirable. Clark, Raventós, Stedman and Stedman (*Quart. J. Exp. Physiol.*, 28, 77; 1938) find that, in general, the hydrolysis of acetylcholine by choline esterase follows the usual course of an enzymic reaction. When high concentrations of the substrate are present, the amount hydrolysed per second is constant, but when the concentration falls below 5×10^{-5} molar, the amount of acetylcholine hydrolysed is approximately proportionate to the concentration. Estimations of the effect on the hydrolysis of variations in the concentration of esterase show that, in all probability, the amount destroyed in unit time varies as the esterase concentration, and that there is no reason to suppose that the rate of hydrolysis increases as some power of the enzyme concentration. Taking these points into consideration, the authors believe that in the animal organism the hydrolysis of even minute amounts of acetylcholine is likely to take at least as long as 0·1 sec.

Fossil Penguin in South Australia

FROM Miocene beds in the cliffs on the east shore of St. Vincent's Bay, South Australia, H. H. Finlayson describes a single bone of a penguin (*Trans. Roy. Soc. S. Australia*, 62, 14; 1938). The bone, a left humerus complete except for the tuberculum externum, was accompanied by several fractured laminæ probably derived from a radius. Among the thirty-five species of fossil penguins now known, the Australian humerus corresponds most closely in dimensions and structural detail with that of *Palæeudyptes antarcticus* which was found in beds of similar age in New Zealand. But the author considers that the variation shown in the humeral characters of penguins and the uncertainty of conclusions as to relationship to be drawn from geographical distribution, until such time as the original centre of distribution is known, precludes the application of a new name to the Australian fossil. The fact that the Tertiary penguins of the Antarctic region show structures which seem to indicate superior terrestrial and inferior aquatic adaptations, according to Lowe, suggests that these forms were comparatively sedentary and coast-frequenting, and this would preclude colonization over long stretches of open sea.

Moisture Conditions within Termite Mounds

IN Pamphlet No. 82 of the Council for Scientific and Industrial Research in Australia, Messrs. R. V. Fyfe and F. J. Gray give an account of the humidity of the atmosphere and the moisture conditions within mounds of the termite, *Eutermes exitiosus*. After a study of the structure of different mounds, and of the composition of the different walls comprising these mounds, it is shown that the termites have developed an extraordinary construction whereby they maintain particular moisture conditions. These conditions prevail in the interior of the mounds and are necessary for the maintenance of the termite colony. They are, furthermore, maintained throughout all conditions of temperature and rainfall which may occur outside the mounds. The structure and composition of the walls of the mounds are stated to be such as to retain the moisture produced as the result of the respiration of the termites. The temperature maintained by the living insects, and the special properties of the mound material, prevent the deposition of this free water where the termites generally live. The mound is, it seems, so constructed as to allow the amount of water production by breathing, and that lost by diffusion and evaporation, to be closely balanced.

Cereal Synonyms

THE Cereal Synonym Committee regards two cereals as synonymous when they present precisely similar morphological characters, and when they also possess identical physiological characters in so far as they can be determined. Even then, by this term they do not necessarily imply that these two varieties are of identical origin, though doubtless in the majority of cases they are. The possibility of two cereals of different parentage presenting such a close, if not complete, similarity as to mask their individuality has not been lost sight of. But the Committee has to deal with facts as they are; therefore, it regards as synonymous all cereals which are identical in the sense used above even when it is known that the origins are different. It should be noted, however, that before the Committee comes to a conclusion concerning the synonymity of any variety, the breeder and/or the introducer is given an opportunity of demonstrating to the Committee such differences as he may claim to exist between his variety and the type variety. On the basis of this definition, the Committee has reached certain decisions on the stocks examined in 1937. *Westerfield White* is considered a synonym for *Setter*, and two wheats of continental origin introduced as Hybrid 40 and Desprez 80, but which have since been renamed in other countries, will be known as Hybrid 40 (Benoist) and Deprez 80 (Joncquois). The latter is a very early ripening short-strawed variety among those recommended for good soils by the National Institute of Agricultural Botany, in Farmer's Leaflet No. 1. *Holdfast*, however, is worthy of special attention in the early ripening group as baking quality is likely to assume greater importance than heretofore, and tests have shown it to be superior to the *Yeomans* in this respect. Early sowing is stressed in the case of the later ripening varieties. As regards oats, the new Aberystwyth *White Winter Oat S.* 147 is suitable for fertile soils, where *Grey Winter* is likely to lodge. *Plumage-archer* and *Spratt-archer* are still the most favoured barleys. Particulars of other good varieties of autumn-sown cereals and the special purposes for which they are adapted, can be obtained on application from the Institute at Cambridge or from any county agricultural organizer.

Hybrid Vigour in Wheat

A STUDY of heterosis or hybrid vigour in wheat has been made by Dr. B. P. Pal and Mr. N. Alam (*Proc. Ind. Acad. Sci.*, **7**, No. 3, Sec. B). They crossed a bearded with a beardless variety of *T. vulgare* from Pusa and compared the F_1 with the parents as regards amount of germination, rate of formation of first leaves, height, tillering, number of leaves, length of ear, number of fertile spikelets, number of grains per ear, weight of grain and yield. A new feature of these experiments was that these comparisons were made when the three crops were grown under different sets of conditions. Heterosis was found, less striking than in maize, and its amount was shown to vary according to the conditions. Thus by sowing at different depths it was found that the F_1 germination was superior only at depths of 4–6 in. The time of sowing (morning, noon or evening) also affected the germination rate. The difference in tillering between the F_1 and the better parent was greater in sowings made early in the season than later, the percentage in favour of the F_1 ranging from 46 per cent to nil. In ear characters the F_1 exceeded the mean of the parents under all conditions, but were not significantly better than the better parent. The results indicate that the expression of heterosis is much influenced by various external factors, and that the optimum conditions for its expression in any particular cross therefore need to be sought.

Fertility of Amphidiploid Hybrids

H. W. HOWARD has made a study of the fertility of amphidiploid hybrids between the radish and cabbage in F_3 and F_4 generations (*J. Genetics*, 36, No. 2). Earlier studies of this cross have been made by Karpechenko and Richharia. Fresh F_1 hybrids were also studied and were found to be of two types. One type had short meiotic chromosomes like the parents, the other had long chromosomes. A variable number of bivalents and occasional trivalents were formed. The chiasmata gave evidence of a reduplication in one chromosome. Some secondary pairing of univalents was observed, as well as bridges and restitution nuclei. The theory of fertility in amphidiploids is considered, and it is pointed out that the types of F_1 pairing may lead to the formation of gametes which have some chromosome segments reduplicated and others deficient. Some of the resulting offspring may not be true amphidiploids and these will show reduced fertility. Some F_4 plants had a much higher fertility, others equal or lower fertility than the F_3. The increased fertility is attributed to the elimination of irregular chromosome pairing. Certain F_3 plants had less than 36 chromosomes.

A New Species of Fungus

Tremella translucens is the name suggested for a new fungus species described by H. D. Gordon (*Trans. Brit. Mycol. Soc.*, 22, Pts. 1 and 2, Aug. 1938). The fructification is a small cushion, not usually more than 2 mm. in diameter, upon dead pine needles. Basidia are quite characteristic of the genus, being divided longitudinally to the base. Dry fructifications have basidia without spores, but on wetting, they

form epibasidia and basidiospores. The new species belongs to the section Tuberculiformes of the genus *Tremella*. Only three species of the section are European, and differ sharply from *T. translucens*, which therefore seems to have a good title to specific rank.

The Violent Earthquake of November 10

VERY large amplitudes were registered on the seismograms for this shock at Hamburg and Stuttgart, described in NATURE of November 19, p. 909. At Hamburg a small primary pulse was discernible at 20h. 30m. 0s., a dilatational *P* wave at 30m. 8s., and *S* at 39m. 41s. At Stuttgart a compressional *P* wave was registered at 20h. 30m. 29s., *S* at 40m. 17s., *PS* at 41m. 5s. and *L* at 52m. From Hamburg, the epicentral distance was thus 8,400 km. and from Stuttgart 8,500 km. The azimuth from Stuttgart was N. 5° E. All this evidence supports the hypothesis of an epicentre in the North Pacific Ocean in the neighbourhood of the Bering Sea and the Aleutian Islands.

Determination of Nicotinic Acid and its Amide

RECENT work on vitamins has shown that nicotinic acid and nicotinamide cure pellagra in human beings and thus act as anti-pellagra vitamins. It is therefore of importance to discover a method of determining and detecting these pyridine derivatives when they occur in traces. Karrer and Keller (*Helv. chim. Acta*, 21, 463; 1938) worked out a colorimetric method based on the reaction between 2 : 4–dinitrochlorobenzene and pyridine discovered by Vongerichte in 1899. In alkaline solution a deep red colour is produced. The method has been used by Karrer and Keller for the determination of nicotinamide in the liver of various warm-blooded animals. König, in 1904, described a colour reaction of pyridine and its derivatives which depended on the fission of the pyridine ring by cyanogen bromide. On addition of aromatic amine, a yellow to yellowish-green colour is produced. Swaminathan has recently used this reaction (NATURE, 141, 830; 1938) to determine nicotinic acid in foodstuffs. H. Kringstad and T. Naess (*Naturwiss.*, 26, 709; 1938) have now reported further investigations on this reaction. They find the intensity of colour is considerably affected by hydrogen ion concentration. By buffering the solution at *p*H 6·1 by a phosphate buffer, and determining the colour intensity when it has reached its maximum (after 7 min. in the case of nicotinic acid) by the extinction method, it is found that the extinction coefficient is directly proportional to the concentration of the pyridine derivative. It is possible by this method to determine nicotinamide in concentration so low as 1 γ per c.c. The shade and intensity of the colour vary with the pyridine derivative used, but the proportionality referred to above holds in all cases.

Free Radicals from Toluene

THERE are three possible modes of decomposition of the toluene molecule on heating (900–1,100°; 0·1–0·5 mm.):

(1) $C_6H_5.CH_3 \rightarrow C_6H_5CH_2- + H.$
(2) $C_6H_5.CH_3 \rightarrow o$- and p-$CH_3C_6H_4- + H.$
(3) $C_6H_5.CH_3 \rightarrow C_6H_5- + CH_3-$

F. Hein and H. I. Mesée (*Naturwiss.*, 26, 710; 1938) have investigated this thermolysis by a method similar to that used by Rice, the free radicals formed being removed by combination with mercury vapour. It has been found that the reaction gives rise entirely to benzyl radicals. The compound $(C_6H_5–CH_2)_2Hg$ is formed by the combination of the benzyl radicals with the mercury vapour, followed by polymerization. This compound is stable at liquid air temperatures, but is decomposed on warming to room temperature giving mercury dibenzyl, $C_6H_5CH_2.Hg.CH_2C_6H_5$ and mercury. It therefore appears that the thermal decomposition of toluene at about 1,000° and at low pressure takes place entirely according to the first reaction mentioned above.

Sound Insulation

IN a communication to the Physical Society on October 28, Dr. J. E. R. Constable of the National Physical Laboratory gave the results of his measurements of the sound-insulating powers of various walls and floors of buildings. In one case a set of six rooms in two stories, rooms 1, 2 and 3 in the upper, 4, 5 and 6 in the lower, about 14 ft. wide, 27, 16 and 18 ft. long respectively were used. Rooms 1 and 2, and 4 and 5 were separated by a plastered 9-inch brick wall, and 2 and 3, and 5 and 6 by a 3-inch plastered clinker concrete wall. The side walls were on one side a 2-inch cavity single brick wall and on the other a plastered 3-inch hollow tile wall. The floors were all 5·5-inch reinforced concrete. A warbling note of frequency 200, 700 or 2,000 was generated in room 2 and the intensity of the sound in the other rooms measured. The reduction of intensity was greater for the high than for the low-pitched note. The average reductions were in room 1, 45 decibels, 3, 40 db. 5, 47 db. 4 and 6, 52 db. The brick wall between rooms 1 and 2 would produce a reduction of 55 db. and the clinker wall between rooms 2 and 3, 43 db. The difference between these results and those found in the rooms is due to the transmission through the side walls, the floors and ceilings of the rooms. In average buildings there is therefore little to gain by partitions producing greater reductions than 55 or 60 db., unless the side walls are improved to a corresponding extent.

Distance Geometries

ONE of the best-known geometrical theorems is that any two sides of a triangle are together greater than the third. From this simple basis an extensive set of "distance geometries" has been developed. Prof. L. M. Blumenthal (*Univ. Missouri Studies*, 13, No. 2; 1938) gives an account of these. They are based on abstract postulates, with a single completely undefined element ***point*** and a single numerical relation ***distance*** between every two points. The theory involves considerable difficulties, and theorems which are true in one kind of distance geometry are not necessarily true in another. To the thoroughgoing pure mathematician, such studies need no justification by reference to anything outside them, but to those of weaker faith it may be comforting to notice that the abstract theory can be applied to determinants, curves and surfaces, and the calculus of variations. There is, at present, no mention of any application to physics. However, in these days, when new attempts to bring physics under the domination of geometry are liable to be made at any time, the physicist must not be surprised if he is suddenly confronted with an alarming horde of such new geometries, armed with mysterious terms and terrifying symbols.

Laugerie-Haute, Dordogne*

THE famous rock-shelter of Laugerie-Haute, on the right bank of the Vézère in Dordogne, which was discovered by E. Lartet and H. Christy in 1862 and recorded by them as a palæolithic site, and has since been explored in part from time to time by archæologists, was under excavation by H. Hauser when war broke out in 1914. It was acquired by the State on Hauser's conviction of espionage. In 1921, MM. Denis and Élie Peyrony began the systematic excavation of the shelter. It had never previously been examined below the Solutrean and Magdalenian levels. The investigations were carried on at intervals over a period of years, the excavation being completed in 1935. The last four years were devoted to the east end of the shelter, which had not been attacked before.

The shelter is of considerable size. It is 180 metres in length. The greater part, measuring 132 metres, was covered by huge masses of rock, which had fallen from the roof in palæolithic times. Its breadth is 35 metres. The excavations, which have been carried down to bed-rock at a depth varying from 4·50 metres to 5·0 metres, have produced some unexpected results, and have thrown an entirely new light on Aurignacian culture.

A shelter of this size, obviously, would not be occupied in its entirety at one time, nor would the duration of occupation be uniform. On the west side, eight, or counting subdivisions, ten levels were distinguished, while in the excavations at the east end of the shelter, it was found that further developments and a new industry were intercalated.

The lowest level (A) above bed-rock at both extremities of the shelter is archæologically sterile; but on comparative evidence from other sites of the area it is assigned to Aurignacian I. The lowest level of occupation (B) which follows, with the culture of a people descended from Combe Capelle and contemporary with Aurignacian II, is assigned to Perigordian III. On the east side, where B is a prolonged occupation, markedly homogeneous in character, there followed a heavy fall of rock which completely covered this area of the occupation. On the west the fall at this time was slight. An occupation (B′) of brief duration, but little later than the preceding, then appears in the eastern section. It was brought to an end by a fall of rock (C) distributed generally over the shelter, which was then abandoned for a prolonged period.

On the west side immediately above the sterile level of rock-fall are deposits with bone and flint artefacts (D) belonging to the final phase of the Aurignacian (Aurignacian V). This industry is recorded in the area for the first time. It is probable that the people were descendants of Cro-Magnon. A level virtually sterile (E) is followed by deposits extending to the back of the shelter (G), in which is an industry of archaic (Mousterian) aspect, but with Solutrean tendencies, termed Proto-Solutrean. On the east side, however, following on the sterile level E, there appears an occupation level varying from 0·20 m. to 0·40 m. in depth (F). The culture, which had not previously been recorded anywhere, and is known only from Laugerie-Haute, and that only on the east side, presents an admixture of Aurignacian and Perigordian characters, evolving new forms with a Magdalenian tendency, for which the term Proto-Magdalenian is suggested. It is also put forward, as a tentative suggestion, that the culture may be the result of a fusion of the Combe Capelle and Cro-Magnon peoples, who, after living in Perigord for some considerable time without intermingling, were forced to unite under pressure from the Solutreans coming in from the east. Above this level is a sterile layer composed of rock-falls, which covered the floor partially only and did not interrupt occupation for more than a brief period. It was followed by the same culture as on the west side (H), a level in which the Proto-Solutrean culture of G is followed by the Solutrean in three stages distinguished by type implements.

Following on, on the west side, (I) is a Magdalenian culture without harpoons. On the east, however, there are three phases of this culture, though occupation would appear to have been continuous, and further there is, apparently, no break between Solutrean and Magdalenian; but the periodical ejection of refuse from the shelter has made it possible to distinguish the various industrial horizons by sterile layers.

During the Magdalenian occupation, heavy falls of rock from the roof caused the shelter to be abandoned. Its inhabitants migrated lower down the slope to Laugerie-Basse, where the lowest level of occupation is Magdalenian III; while the great shelter of La Madeleine, four kilometres away, higher up the slope, was not occupied until Magdalenian IV.

A passage-way formed between the fall of rock and the wall of the Laugerie-Haute shelter on the east side has, above a layer of rubble and earth (J), an exiguous level (K) in which appear traces of a culture with harpoons having a single row of barbs—Magdalenian V.

From this time onward the shelter was completely abandoned; but there is evidence of Azilian and neolithic settlement on the site.

A remote corner of the shelter on the west side, approached by a narrow passage only, which from its character can have been neither dwelling nor workshop, must have been a temple, a Holy of Holies, probably, of a neighbouring tribe, similar to those of La Mouthe, Font-de-Gaume, and Les Combarelles. It was probably used by the people of Laugerie-Basse. The walls bear engravings and examples of art in the combined technique of engraving and sculpture in relief.

A number of general conclusions are drawn from this evidence, among which may be mentioned that it would now appear that the Perigordian, the Aurignacian, the Proto-Magdalenian and the Magdalenian cultures form a single 'block', into which, *in Perigord*, the Solutrean intrudes for a certain period of time and then disappears, in so far as the

* Laugerie-Haute, près des Eyzies (Dordogne). Par Denis et Élie Peyrony. (Archives de l'Institut de Paléontologie humaine, Mémoire 19.) Pp. 84+7 plates. (Paris: Masson et Cie., 1938.) 80 francs.

culture is concerned. Further, the climate of the Upper Palæolithic would appear not to have been uniform throughout its duration. It was cold in late Mousterian and Perigordian I, glacial in Aurignacian I, and so continuing up to the beginning of Solutrean, when it became milder. It continued to be milder throughout that period and in Magdalenian I–V. It was glacial in Magdalenian V and VI, and milder to temperate from Magdalenian through Azilian, Tardenoisian and neolithic.

Non-Destructive Testing

UNDER the auspices of the Institution of Electrical Engineers, a whole-day discussion was held on non-destructive testing on November 25. Seven introductory papers were arranged for and printed by a new association—the Joint Committee on Materials and their Testing.

The first paper was by Dr. A. P. M. Fleming and Mr. B. G. Churcher, and discussed electrical and magnetic methods. Seeing that modern physics has arrived at the conclusion that fundamentally all matter and all physical phenomena are electrical manifestations, and that electrical and other forms of energy have long been a matter of common experience, it is natural that electrical and magnetic methods of testing materials should be in everyday use. The authors divide these methods into three classes. In the first are included the methods used for measuring the intrinsic electrical and magnetic properties of materials; in the second, the methods devised for the assessment or detection of a non-electrical or non-magnetic property or condition by means of electrical or magnetic effects in a material; finally, they describe the methods in which electricity or magnetism is used indirectly or incidentally in the assessment of a non-electrical or non-magnetic property of a material. In this latter class are included the measurements of dimensions, velocity, acceleration, fluid flow, pressure, temperature, illumination, etc. As these are not methods of testing materials, they have as a rule only been touched upon, but the modern methods of considering the thermal emissivity of surfaces, the specific heats of liquids and solids and the thermal resistivity of materials are specially mentioned. The greatest stress is laid on testing the magnetic properties of ferro-magnetic materials at high and low frequencies, as a knowledge of these is essential to the electrical industry. Various methods are described for detecting flaws or cracks in steel by means of a magnetic powder or by tracing out the lines of force at the surface by a small compass needle.

The second paper was by Dr. R. Berthold (Germany), who describes magnetic and electric devices for bridging the gaps left and overcoming some of the disadvantages which occur with X-ray and radium (gamma radiation) testing. He shows how the magnetic powder can be employed for detecting flaws in castings, worked objects, joints in metals, etc. In these cases the metals tested must be very carefully demagnetized after the test, particularly those to be used in aircraft.

In a paper by Dr. V. E. Pullen, who was the first to start testing metallic structures by X-rays at Woolwich twenty-two years ago, it is stated that radiological testing is incomplete without the use of complementary methods which usually become apparent in the course of the investigation. Illustrations are given of some of the elaborate apparatus used at Woolwich and of the radiographs that can be obtained by their use. The paper by J. E. de Graaf (Holland) describes industrial radiography as now practised on the continent of Europe. Mobile apparatus is often used in this work. The necessary apparatus is transported in a motor vehicle which houses also the dark room and accessories. About sixteen such installations are in operation on the Continent. There are one or two in Belgium, one in the Netherlands and about thirteen in Germany. The staff per car is composed of two or three men skilled in photographic technique. The results are interpreted by experts, who generally belong to a central body so as to ensure that a uniform standard is maintained.

Dr. Dorey gave an account of acoustic and general methods of non-destructive testing. Perhaps the oldest acoustic method of testing is that of listening to the sound produced by giving an article a sharp blow. It is instinctive on the part of the engineer who doubts the soundness of an article to give it a tap and listen for the ring. The production of a pure note corresponding to the natural frequency of vibration of the article may be taken as evidence that the article is sound and free from serious defects. A refinement of this method has recently been effected by the use of an ordinary medical stethoscope. For the testing of structural welds, a rubber cap is fitted over the searching end of the stethoscope, which is then placed against the welded plate whilst the weld under examination is tapped with a hammer. A high-pitched reedy sound occurring in the primary period of sound caused by the hammer blow indicates the presence of defects in the weld. So far this method has not been very successfully developed in Great Britain.

One of the most interesting and valuable methods of non-destructive testing has been in the design of objective noise meters. This work has been carried out in the National Physical Laboratory. The instruments are of the microphone-amplifier-meter type which have been adjusted for measuring the equivalent loudness of noise. Architects and building contractors now pay great attention to the acoustic properties of the materials used for walls, ceilings and floors. The tests are usually carried out by reverberation methods, and the sound-absorption coefficients are calculated from the period of reverberation of the chamber. Hydraulic tests are widely used in industry for proof-testing of pipes and hollow containers.

Dr. F. Förster and Prof. W. Köster (Germany) described a new apparatus for measuring the modulus of elasticity and the damping capacity of a material. They point out that the damping and the modulus of elasticity are quantities which, in contrast to many other technical values, possess an exact physical meaning.

Messrs. H. H. Lester, R. L. Sandford and N. L Mochel, at the request of the American Society for Testing Materials, jointly undertook to write an account of non-destructive testing as practised in the United States. Radiographic methods are widely used in the States. Pressure-vessel manufacturers use fifty-seven installations, and there are thirty-one installations for various other applications. The American Society of Mechanical Engineers has greatly helped boiler-makers by constructing the A.S.M.E. Boiler Construction Code of definite standards of soundness to which manufacturers have to build. Porosity conditions are defined by pictures. Rejectable defects such as cracks and unfused regions are specifically designated and limits of toleration are established for slag inclusions. In the paper emphasis has been given to practical applications and to technological research of direct bearing on industrial practice. In conclusion, methods and regulations for testing porcelain and glass are given. All high-voltage porcelain parts designed for service above 6·6 kilovolts are given a 'routine' flash-over test. In addition, routine mechanical tests are made on all suspension insulators. The Polaroid Corporation has recently developed a glass strain detector built for the routine inspection of glass articles during the process of manufacture.

Rothamsted Experimental Station

THE Rothamsted Report for 1937* contains the results of experiments carried out at that Station during the year, and of crop trials undertaken at Woburn, and at a number of commercial farms, extending over a large area. Short accounts of the work of some of the departments of the Station are included, and also an extended summary of the research carried out in the Plant Pathology Department since its formation twenty years ago.

The experiments with chalk, discussed in this report, are of great interest because of the Government subsidy for the use of various forms of lime. Although liming is such an old practice, and although a large number of field trials have been carried out on the subject, there is a lack of precise knowledge on many aspects of the problem. Thus, it is often said that magnesium limestones are detrimental; but experiments planned at Rothamsted, and carried out in various parts of Britain, have given no evidence of this. The residual value of chalk has also been investigated and distinct improvements were obvious in crops some years after application; on an acid, sandy soil, for example, there is little sign of the effect of the dressing of lime disappearing after six seasons of cropping.

In a country with large numbers of live-stock, as in Great Britain, the conservation and utilization of farmyard manure is an important consideration, and many aspects of these problems have been under investigation at Rothamsted from its early days. In the 1937 report, the results of the early trials, which started in 1852, are dealt with briefly as a preliminary to the consideration of the more modern work. The earlier, long-period experiments showed that farmyard manure could give yields as high as those given by the best combination of artificial manures, and that it had considerable cumulative effects; in one instance, the increases in yield were considerable sixty-five years after the last application of dung. A number of modern, replicated experiments show that the response in potatoes averaged 2·1 tons per acre, and, in sugar beet, 1·3 tons per acre at Rothamsted. The increase resulting from 10 tons of farmyard manure was about equivalent to that from 2 cwt. of sulphate of ammonia. Experiments were also carried out to investigate the effects, on the yields of potatoes, and of sugar beet, of different methods and times of application of farmyard manure. With both crops, late application was superior to the earlier dressing. With potatoes, the application of the manure in the rows, at planting time in the spring, gave an increase of between one and two tons per acre more than when it was ploughed in in autumn. Finally, a number of experiments were undertaken to find whether artificials may be profitably applied on land that is also being dunged. The responses to sulphate of ammonia were increased in the presence of dung, while, with sulphate of potash, there was a small decrease.

An important aspect of the organized schemes of manuring experiments consists in the accumulation, by the Chemistry Department, of data which may make it possible to predict the fertilizer requirements of soils from their chemical analyses and textures. In 1936 and 1937, sugar beet gave much larger responses than in the three preceding dry seasons, and there was an opportunity of testing laboratory methods in this respect. The amount of inorganic nitrogen, obtained in the soil after incubation, gave a good degree of correlation with responses to sulphate of ammonia, while, with phosphoric acid, the fraction soluble in acetic acid corresponded to responses from superphosphate. It is unnecessary to emphasize the importance of this line of work at Rothamsted, as it will not only assist the individual agricultural adviser, but will also greatly increase the amount of useful information that can be obtained from soil surveys.

A note of this brevity cannot do more than mention the work of the Plant Pathology Department, summarized in this report. Among the important contributions from this laboratory must be cited the discovery of the 'green wart' method of infecting potatoes with wart disease; this enables susceptibility or immunity to be determined within as many weeks as had hitherto required years. The investigations in this laboratory into the fundamental nature of virus diseases were extended after the Imperial Agricultural Conference of 1927, and the problem of the ultimate nature of these diseases is tackled from many angles. In one study, for example, it has been

* Rothamsted Experimental Station; Lawes Agricultural Trust. Report for 1937. Pp. 225. (Harpenden: Rothamsted Experimental Station, 1937.) 2s. 6d.

found possible to arrive at estimates of the size of certain of the plant viruses. The relationship between the insect carrier and the virus is also under investigation, and some striking results have been obtained already in regard to the connexion between degree of infection, season, and length of feeding times on the infected plant.

In addition to discussions of the various investigations in progress, the report contains a wealth of other material, such as the farm report, also notes on the insect pests and fungus diseases at Rothamsted and Woburn. Many branches of agricultural science gain from the information given in this report; the close connexion between laboratory and farm, together with the carefully planned field trials, give a high value to all the data supplied.

Precision Methods of Measuring Stellar Radiation

IN a communication, dated October 17, from the Smithsonian Institution, Washington, an account is given of experiments made by Dr. Charles G. Abbot, secretary of the Institution and Mr. W. H. Hoover, of the Smithsonian staff, at the Mount Wilson Observatory of the Carnegie Institution at Washington, on the total energy radiated by distant stars in narrow wave-length bands. For the measurement of electric current they used a galvanometer which was twenty times as sensitive as any instrument of this sort used in the past. A magnetic shield for this very sensitive galvanometer was made for the Institution by the late Dr. Elihu Thomson, of the General Electric Company, one of the world's foremost inventors of electrical devices. The galvanometer itself was made at the Institution and will detect a current variation of $1/10^{13}$ of an ampere.

The galvanometer is attached to a thermocouple, the standard astronomical instrument for measuring extremely minute amounts of heat energy. The thermocouple used by Dr. Abbot and Mr. Hoover is a more sensitive, and at the same time a more robust instrument, than any hitherto used.

The efficiency of the new devices has just been tested in California, using the Carnegie Institution's 100-inch telescope, with encouraging results. Dr. Abbot and Mr. Hoover measured with a high degree of precision the relative energies in narrow bands of the spectra of a number of the brighter stars. The total heat which reaches the earth from all the thousands of millions of stars of the Milky Way is extremely small. If the earth depended on this heat alone, the temperature would be approximately −270° C. Many individual stars in the galaxy are many times hotter than the sun, but their radiation is soon dissipated in the immensity of space.

Astronomers have had for many years instruments sufficiently delicate to measure the total radiation of several of the planets of the solar system. It has also been possible within the past few years to measure the total radiation of selected single stars. The aggregate light of such a star is focused on the thermocouple, essentially a junction of two wires made of different kinds of metal, through which an electric current is caused to flow by the minute rise of temperature produced by the stellar radiation, any variation in the temperature of the junction produces an alteration in the current measured by the galvanometer. The amount of the radiation energy necessary to produce a change in the current, the distance of the star and the rate of dissipation of stellar radiation in space being known, it is possible to calculate the actual heat from the star itself.

Dr. Abbot and Mr. Hoover have gone a step farther. In the radiation of almost every star are to be found all the elements of the spectrum from the infra-red to the ultra-violet. Actually the proportions of infra-red, visible light and ultra-violet differ enormously in the radiation of different classes of stars. It was the problem of measuring the approximate amount of radiation from a star in different narrow bands of wave-lengths that the Smithsonian astronomers set themselves. This task required the most precise measurements ever attempted.

Experience for the task was drawn from two sources. A division of the Institution has been engaged for years in measuring the precise effects on plants of illumination from different wave-lengths of light. This required further development of an instrument known as the Christiansen filter to segregate narrow bands of wave-lengths from the light and heat of an arc lamp, and also of improvement of the thermocouple. There seems little connexion between oat seedlings growing in boxes and giant stars a 1000 light-years away, but all Nature seems tied together so inextricably that the development of this technique connects the one inextricably with the other. The other source was the work of the Smithsonian Institution's observatories set up on distant mountain tops in various parts of the world, the work of which is to make very precise measurements daily of minute variations in the radiation of the sun. This has called for more and more responsive heat-measuring instruments.

Dr. Abbot began the present work in 1923, using an instrument called the radiometer prepared for him by the late Dr. E. F. Nichols. In 1928 he returned to the task, using a fly-vane radiometer of his own construction in which the sensitive element was a small piece cut from the wing of a house fly. He has hoped to continue the experiments ever since with instrumental improvements giving greater sensitiveness. A point has now been reached where the measurement of the energy in narrow stellar wave bands can be made with high accuracy.

It is possible, however, that much greater responsiveness will be attained within the next two years, before the 200-inch telescope, with which it is planned to carry out the main programme of measurements, is set up at Mount Palomar in California. It may be possible to improve the thermocouple, to eliminate the element of drift due to the sensitivity of the two joined elements.

The last measurements made by Dr. Abbot were at Mount Wilson ten years ago. At that time the greatest swing of the recording light spot that could be attained was only about one millimetre. This year

Mr. Hoover easily obtained swings of twenty millimetres, which is equivalent to a twentyfold preciseness in his measurements.

Far-reaching results may be attained with the new technique. A means is now at hand of determining with considerable accuracy temperatures, depths and compositions of the atmospheres of stars, and this will make possible more accurate estimates of the size and nature of stellar bodies.

Economics of Industry

ARISING out of the Conference held in 1937 by the International Industrial Relations Institute, when the theme was productivity and standards of living as influenced by industrial relations, the Institute has arranged a series of publications, the I.R.I. Social Economic Series, to present the results of its studies. Two of these have now appeared, the first by A. Carrillo on "Mexico's Resources for Livelihood" including a general introduction to the series on the world's natural resources and standards of living (Mexico's Resources for Livelihood: a Study of the Influence of Foreign Ownership. By Alejandro Carrillo. Pp. 34. The Hague and New York: International Industrial Relations Inst., 1938. 25 cents).

This introduction outlines the field opened up, including an analysis of the distribution of the world's raw materials and a survey of the hitherto abortive efforts to deal with the problem through international action. The implications of power production for economic organization are also considered, and in addition to summaries of the main arguments in the papers submitted to the 1937 Conference a number of suggestions for immediate action are outlined. Mr. Carrillo's special study gains further interest in view of the expropriation of oil by the Mexican Government since the paper was written, and it facilitates appreciation of the situation in Mexico and the important moral achievements of the revolution.

The second paper, by M. Yergan on gold and poverty in South Africa, is a study of economic organization and standards of living; it is yet another indictment of the labour policy pursued in South Africa with its deliberate exploitation of native labour as part of the natural resources of the country (Gold and Poverty in South Africa: a Study of Economic Organisation and Standards of Living. By Max Yergan. Pp. 24. The Hague and New York: International Industrial Relations Inst., 1938. 15 cents). The importance of workers' living standards as an element in the problem of raw materials is again emphasized, and while the report recognizes that the errors and dangers of the policy hitherto pursued are now perceived by an increasing body of European opinion, the material it presents overthrows a conception of trusteeship under the conditions which prevail in South Africa. The importance of encouraging and co-operating with all those in South Africa, whether African or European, who are aware of the dangers and real needs, and striving to meet them, is emphasized, as well as the need for strenuous efforts to eradicate the hates and prejudices which repression and exploitation have developed within the ranks of both Africans and Europeans.

Science News a Century Ago

Temperature of the Crust of the Earth

WITH the assistance of the British Association, J. D. Forbes in 1837–38 made determinations of the temperature of the soil in the neighbourhood of Edinburgh, the results of his experiments being given in a paper read to the Royal Society of Edinburgh on December 3, 1838, entitled "Discussion of One Year's Observations of Thermometers sunk to different Depths in different localities in the Neighbourhood of Edinburgh".

The principal purpose of the experiments undertaken by Forbes was to ascertain the progress of solar heat in the crust of the earth, and had no immediate reference to the question of central heat. With the view of rendering the observations comparable with those at Paris and Brussels, the lowest thermometers had their bulbs 24 French feet (= 25·6 English) below the surface. Other thermometers were placed at depths of 12, 6 and 3 French feet. The observations were begun in February 1837 and were continued weekly.

The three stations for the experiments were at the Observatory, Calton Hill, in the sand in the Experimental Garden and in the compact coal formation sandstone of Craigleith Quarry. Among other results obtained, Forbes found that at the greatest depths the annual range temperature was 1·45° F. at the Observatory, 2·1° F. at the Garden and 4·1° F. at the Quarry.

Footprints of the *Chirotherium*

AT a meeting of the Geological Society on December 5, 1838, one of the communications was "An Account of the Footsteps of the *Chirotherium* and five or six other unknown animals lately discovered in the quarries of Storeton Hill, between the Mersey and the Dee". The communication was made by the Natural History Society of Liverpool and was accompanied by drawings by J. Cunningham. In 1834 there were discovered in several quarries at the village of Hessburg near Hildberghausen, casts in a grey quartzose sandstone, resembling to some extent a human hand, and for which Prof. J. J. Kaup proposed the provisional name of *Chirotherium*. In June 1838, similar casts were discovered in the Storeton Hill quarries. The Natural History Society of Liverpool appointed a committee to report on these.

The red sandstone of the peninsula of Wirral may be divided into three layers: a lower consisting of a red or variegated sandstone and conglomerate, a middle of white and yellow sandstone, and an upper or red or variegated marl and sandstone containing pebbles of quartz. It is the middle division which was worked at the quarry. The strata there are of unequal thickness, and are separated by thin seams of whitish clay. The casts appear to have been moulded in impressions made by the *Chirotherium* and other animals walking over the clay.

The animal had been tracked by its marks 16 ft. on one stone. Although the footsteps of the *Chirotherium* are the most prominent there are slabs covered by raised casts apparently made by tortoises and saurian reptiles.

Societies and Academies

Paris

Academy of Sciences (*C.R.*, 207, 753–812, Nov. 2, 1938).

H. DESLANDRES : Application of the new analysis of molecular spectra to some molecules of particular interest. Applications to the chlorides of phosphorus.

L. ROY : Electric effects in a system of isotropic bodies.

S. MAZUR : Some characteristic properties of Euclidean space.

A. KOLMOGOROFF : A generalization of the inequality of J. Hadamard between upper limits of successive derivatives of a function.

V. G. AVAKUMOVIĆ : Inversion of a process of summation, with application.

E. SZPILRAJN : Independent ensembles and non-separable measures.

G. GODEFROY : Stability of rows of eddies.

J. K. DE FÉRIET, A. MARTINOT-LAGARDE and G. ROLLIN : An apparatus for determining the modulus and direction of velocity in a fluid.

H. MINEUR : Statistical equilibrium of the masses of stars with three unequal axes.

A. MARCELIN : New observations on the increase of viscosity in a mineral oil at rest.

B. KWAL and M. LESAGE : A method of utilizing ordinary counting mechanisms for counting a rapid succession of phenomena.

J. CATHALA and J. CLUZEL : Spectrophotometric study of the slow hydrolysis of ferric salts.

C. JAUSSERAN : Absorption spectrum of the developed photographic image.

V. DOLEJŠEK and M. ROZÍVAL : A method of focalization utilizing the Seemann *couteau*.

J. ORCEL and MLLE. S. CAILLÈRE : New observations on the transformations of magnesium prochlorites under the action of heat. X-ray crystal analysis of the minerals.

J. JUNG, R. PÉCOIL and J. RICHARD : Stratigraphy and facies of the Stampien of the central Limagne.

C. ARAMBOURG and J. FROMAGET : The quaternary bed of Tam Nang (North Annamese Range); its stratigraphy and faunas.

R. JACQUOT and R. RAVEUX : Influence of the food concentration on the development of isolated seedlings cultivated in the dark. Dry weight increases and water content decreases with increase of concentration of glucose.

M.-M. JANOT and E. CIONGA : Catuabol from the bark of catuabach (*Trichilia* sp.).

M. PAGET and R. BERGER : Researches on the Schryver-Fosse reaction and on its analytical applications.

A. BOUTARIC : Study of colloidal solutions by combined measurements of viscosity and optical density.

M. DOLADILHE : Researches on irreversible coagulation.

P. GRABAR : Action of pepsin on anti-pneumococcic antibodies.

L. PARROT and A. CATANEI : Factors in the occurrence of epidemics of paludism in Algeria. A study of the three types of infection, under conditions exceptionally favourable to infection and re-infection, in 1878 Berbers by regular blood examinations extending over fourteen months. A form of resistance is established at about ten years of age.

(*C.R.*, 207, 813–880, Nov. 7, 1938).

M. BRILLOUIN : Inevitable instability of a heavy liquid which rotates, without relative movement, with a solid nucleus which it surrounds; oceanographic and geodetic consequences. Contrary to views held since the time of Newton and Laplace, no permanent configuration of the liquid stationary with regard to axes of the revolving solid is stable under these conditions.

A. COTTON : Optical measurement of very intense continuous currents.

A. BLONDEL : Application of Maxwell's equations for transformers to circuits imperfectly coupled by iron cores; tuning to low-frequency resonance.

L. ROY : Electrostatic effects in a system of isotropic bodies.

P. LEJAY : Gravity measurements in the Philippines.

E. J. GUMBEL : The deficiency of increase median over a period of years. Application to the statistics of river floods.

L. PASQUALINI : Extension of a property to the whole of an ensemble.

M. BRELOT : Potential and series of sub-harmonic functions.

R. DUCHÊNE and A. MARTINOT-LAGARDE : Mean speed associated with motion in a fluid in turbulent flow.

G. GARCÍA : General problem of exterior ballistics : third and fourth approximations.

G. BADARAU : Passage of corpuscles across Coulomb potential barriers.

P. VAN RYSSELBERGHE : Generalization of thermodynamic potentials deduced from affinity.

J. BÉTHENOD : Maintenance of the movement of a pendulum by means of an alternating current of frequency higher than its own frequency.

B. TSAÏ : New method for the measurement of heavy currents. The magnetic flux in a flexible solenoid surrounding the conductor is measured.

J. THIBAUD and P. COMPARAT : Discrete groups of particles emitted in the course of the disintegration of nitrogen by fast neutrons.

P. EHRENFEST, JUN., and A. FRÉON : Spontaneous disintegration of mesotrons, the particles constituting the penetrating cosmic rays.

B. PONTECORVO : A soft radiation emitted at the time of the capture of neutrons by nuclei.

C. MAGNAN : Measurement of γ-radiation of high frequency by the method of pair formation.

P. LACOMBE and G. CHAUDRON : Study by X-rays of the recovery of the solid solution, aluminium-magnesium.

C. DUVAL and G. MAZARS : Identification [by qualitative micro-analysis] of the halogens.

H. CLÉMENT : Magnesium bromopentamethylbenzene.

V. MIRONOVITCH and A. VIAUT : Complex structure of the lower stratosphere.

H. MARCELET : Presence of free and combined glycerol in the watery juice of the olive.

R. SOUÈGES : Embryogeny of the Boraginaceæ; development of the embryo in *Echium vulgare* L.

P. CHABANAUD : Correction of a special point concerning the morphology of the hypopharyngeal musculature of the Achiridæ.

G. SANDULESCO and A. GIRARD : A new method for the quantitative separation of alcoholic compounds.

Cracow

Polish Academy of Sciences and Letters (*C.R.*, Nos. 6–7, June 17, 1938).

S. SZCZENIOWSKI, ST. ZIEMECKI and K. NARKIEWICZ-JODKO: Specific ionization characterizing cosmic rays. Measurements made during a free balloon ascent on May 14, 1938, indicate that ionization at heights of 5·5–10 km. is proportional to the density of the gas in the ionization chamber.

T. BANACHIEWICZ: Problem of the variations of the solution in the method of least squares.

W. ŚWIĘTOSŁAWSKI: Contribution to the study of phenomena at the critical point.

L. MARCHLEWSKI and W. BEDNARCZYK: Absorption of ultra-violet radiation by organic substances. (48) Azines and analogous compounds.

L. MARCHLEWSKI and J. CHOLEWIŃSKI: Absorption of ultra-violet radiation by organic substances. (49) Indirubine and indigotine.

B. SKARŻYŃSKI: Spectrographic studies of compounds of the flavone type.

K. DZIEWOŃSKI and MLLE. M. MARUSIŃSKA: Studies of 1-methyl-4-aceto-naphthalene.

K. DZIEWOŃSKI, K. STEC and P. ZAGAŁA: Ketones derived from 2,6-dimethylnaphthalene.

K. DZIEWOŃSKI, MLLE. M. MARUSIŃSKA and J. MOSZEW: Syntheses and transformations of compounds of the type of the 2-naphthyl-4-arylaminoquinolines.

ST. PAWŁOWSKI: Morphology of the southern edge of the plateau of Lublin.

J. NOWAK: Problem of the limits of the Polish oil basin in the Carpathic flysch.

B. KRYGOWSKI: Studies of elastic materials of quaternary origin with the aid of geological and petrographical methods.

J. KOVATS: Influence of the presence of iron and of molybdenum on one hand, and of the soil humus or humus ash on the other hand, on the fixation of nitrogen by *Azotobacter*.

J. BIBORSKI: Histological structure of the veins of *Gadus morrhua*.

MLLE. J. JANISZEWSKA: Researches on the life and development of internal parasitic worms of *Pleuronectes flesus* L.

F. PAUTSCH: Role of the medullary tube and of the dorsal cord in the development of the tail of tadpoles of *Rana temporaria*.

J. MAKÓLSKI and ST. SMRECZYŃSKI: New researches on the Pleistocene Coleoptera of Łeki Dolne near Pilzno.

Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

LECTURER IN ELECTRICAL AND MECHANICAL ENGINEERING in the Stockport College for Further Education—The Director of Education, Town Hall, Stockport (December 5).

TEACHER OF CHEMISTRY in the Northern Polytechnic, Holloway, London, N.7—The Secretary (December 6).

LECTURER IN MECHANICAL ENGINEERING in the Burnley Municipal College—The Director of Education, Education Offices, Burnley (December 8).

HEAD OF THE ENGINEERING DEPARTMENT of the Hendon Technical Institute—The Secretary, Education Offices, 10 Great George Street, S.W.1 (December 9).

LECTURER IN EDUCATION AND PSYCHOLOGY in Rhodes University College—The Secretary, High Commissioner for South Africa, Trafalgar Square, London, W.C.2 (December 10).

LECTURER IN CHEMISTRY in Rhodes University College, Grahamstown—The Secretary, High Commissioner for South Africa, Trafalgar Square, London, W.C.2 (December 17).

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Monday, December 5

ROYAL GEOGRAPHICAL SOCIETY, at 5.—F. F. Ferguson: "Famine and Water-Supply in Western Rajputana".

UNIVERSITY OF LEEDS, at 5.15.—Dr. L. Dudley Stamp: "The Utilisation of Land in Britain".*

Tuesday, December 6

NORMAN LOCKYER LECTURE (in the Goldsmiths' Hall, Foster Lane, Cheapside, London, E.C.2), at 4.—Dr. H. Spencer Jones, F.R.S.: "The Atmospheres of the Planets".

Wednesday, December 7

SOCIETY FOR THE STUDY OF ALCHEMY AND EARLY CHEMISTRY (at Queen Mary College, London), at 8.—J. C. Gregory: "From Magic to Science".*

Thursday, December 8

ROYAL SOCIETY, at 4.30.—Dr. Irving Langmuir, For.Mem.R.S.: "Molecular Films" (Pilgrim Trust Lecture).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—H. A. T. Fairbank: "Increased and Decreased Density of Bone with Special Reference to Fibrosis of the Marrow" (Robert Jones Memorial Lecture).

Friday, December 9

PHYSICAL SOCIETY AND METER AND INSTRUMENT SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers), at 7.—Discussion on "Electro-acoustics" to be opened by Dr. C. V. Drysdale.

ROYAL INSTITUTION, at 9.—Dr. Irving Langmuir, For.Mem.R.S.: "The Properties and Structure of Protein Films".

Reports and other Publications

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 781, Vol. 237: Propagation of Wave-packets incident obliquely upon a Stratified Ionosphere. By Dr. H. G. Booker. Pp. 411–451. 5*s*. Series B: Biological Sciences. No. 559, Vol. 229: The Potato Virus "X", its Strains and Reactions. By R. N. Salaman. Pp. 137–217+plates 18–25. 15*s*. (London: Cambridge University Press.) [811

Report of Committee on Evacuation. With a Covering Memorandum by the Secretary of State for the Home Department. (Cmd. 5837.) Pp. iv+39. (London: H.M. Stationery Office.) 9*d*. net. [811

Board of Control (England and Wales). Report on Cardiazol Treatment and on the Present Application of Hypoglycæmic Shock Treatment in Schizophrenia. By Dr. W. Rees Thomas and Dr. Isabel G. H. Wilson. Pp. 70. (London: H.M. Stationery Office.) 1*s*. net. [911

Royal Meteorological Society. Bibliography of Meteorological Literature. Prepared by the Royal Meteorological Society with the collaboration of the Meteorological Office. Vol. 4, No. 5 (January–June 1938). Pp. 235–294. (London: Royal Meteorological Society.) 2*s*. 6*d*. net. [1011

Gas Works Effluents and Ammonia. By Dr. Arthur Key. Pp. 152. (London: Institution of Gas Engineers.) 5*s*. net. [1111

London School of Hygiene and Tropical Medicine (University of London), incorporating the Ross Institute. Report on the Work of the School for the Year 1937–38. Pp. xiv+118. (London: London School of Hygiene and Tropical Medicine.) [1111

University of Cambridge: Solar Physics Observatory. Twenty-sixth Annual Report of the Director of the Solar Physics Observatory to the Solar Physics Committee, 1937 August 1–1938 July 31. Pp. 4. (Cambridge: Solar Physics Observatory.) [1211

Other Countries

Bulletin of the Bingham Oceanographic Collection. Vol. 6, Art. 5: A Contribution to the Life Histories of Atlantic Ocean Flying-fishes. By C. M. Breder, Jr. Pp. 126. (New Haven, Conn.: Yale University.) [1011

Annuario del Reale Istituto Lombardo di Scienze e Letture, 1938. Pp. 220+51 plates. (Milano: Reale Istituto Lombardo.) [1211